APPENDIX B

COMMENTS BY CHAPTER

BDCP DRAFT PLAN

BDCP DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT

I. DRAFT BDCP PLAN

Decision tree approach for Alternative 4 (FROM Judy Meyer)

The EIR/EIS leaves open the key question of how the altered outflows would affect fish for Alternative 4. Instead it proposes a ten-year research program that is to provide, upon completion of the new conveyance, "the fall and spring outflow criteria that are required to achieve the conservation objectives of the BDCP for delta smelt and longfin smelt and to promote supply objectives of the BDCP" (p. 3-207). The proposed program would evaluate various combinations of operational spring and fall flows, some of which are expected to have adverse impacts on fish if restoration is not effective (e.g., EIR/EIS 11-1293, 11-1296, 11-1297). Appropriate questions to be answered by the studies and competing hypotheses are stated, but we found little basis for judging the program's adequacy and prospects. Missing elements include: (1) description of the scientific approach and monitoring to be used, (2) assessment of the range of year types (extremely wet to extremely dry) required for success, (3) consideration of which restored habitats will need to be functioning to test the hypothesis that additional habitat and improved food resources will benefit fish as much as would enhanced spring and fall outflows, (4) criteria that will be used to make the decision on which outflows will be required (e.g., a threshold population size that needs to be achieved?), and (5) the outflows that will be required if the research program does not provide a definitive answer.

II. DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT

Chapter 3, Summary of Alternatives

Three general strategies for Sacramento-San Joaquin Delta exports are examined:

- Through-Delta water exports (2 alternatives, plus existing conditions),
- Dual exports with a combination of intakes south and north of the confluence of the Sacramento and San Joaquin rivers (11 alternatives), and
- Peripheral exports exclusively from north-of-confluence intakes (3 alternatives).

These alternatives and existing conditions are summarized in Table 1 and mapped in Figure 1. All alternatives have a combined physical export capacity of about 15,000 cfs. Each physical alternative has a specific set of operating policies employed in its analysis. Dual conveyance Alternative 4 (the BDCP CEQA preferred alternative) is examined with 4 operational scenarios. Habitat restoration actions also often vary significantly between physical alternatives, as summarized in Table 2. Variants in operating policies are summarized in Table 3. A special discussion of Alternative 9, a very different through Delta alternative is included at the end of this discussion.

Table 1. Summary of alternatives

Alternative	Strategy	Conveyance Alignment	Physical Export Capacities, cfs			Operations
			Total	North	Intakes	
Existing Conditions	Through Delta	Delta Cross Channel, sloughs, and reverse flows	15,000	0	South Delta	Existing conditions
No Action	**Through Delta**	Delta Cross Channel, sloughs, and reverse flows	15,000	0	South Delta	Includes sea level rise and climate warming
9	Through Delta	Separate Corridors, Screened at Delta Cross Channel and Georgiana Slough	15,000	0	South Delta	Scenario G
5	**Dual**	Pipeline/Tunnel	15,000	3,000	North & South	Scenario C, tidal habitat to 25,000 acres
3	Dual	Pipeline/Tunnel	15,000	6,000	North & South	Scenario A
4 (CEQA Preferred)	Dual	Modified Pipeline/Tunnel	15,000	9,000	North & South	Scenario H (4 variants)
7	Dual	Pipeline/Tunnel	15,000	9,000	North & South	Scenario E + 20 miles of channel margin habitat enhancement and 10,000 acres of seasonal floodplain
8	Dual	Pipeline/Tunnel	15,000	9,000	North & South	Scenario F + up to 1.5 MAF more Delta outflow
1A	Dual	Pipeline/Tunnel	15,000	15,000	North & South	Scenario A
1B	Dual	East Canal	15,000	15,000	North & South	Scenario A
1C	Dual	West with West side intakes	15,000	15,000	North & South	Scenario A
2A	Dual	Pipeline/Tunnel	15,000	15,000	North & South	Scenario B
2B	Dual	East Canal	15,000	15,000	North & South	Scenario B
2C	Dual	West with West	15,000	15,000	North & South	Scenario B

		side intakes				
6A	**Isolated**	Pipeline/Tunnel	15,000	15,000	North Delta	Scenario D
6B	Isolated	East Canal	15,000	15,000	North Delta	Scenario D
6C	Isolated	West, with West side intakes	15,000	15,000	North Delta	Scenario D

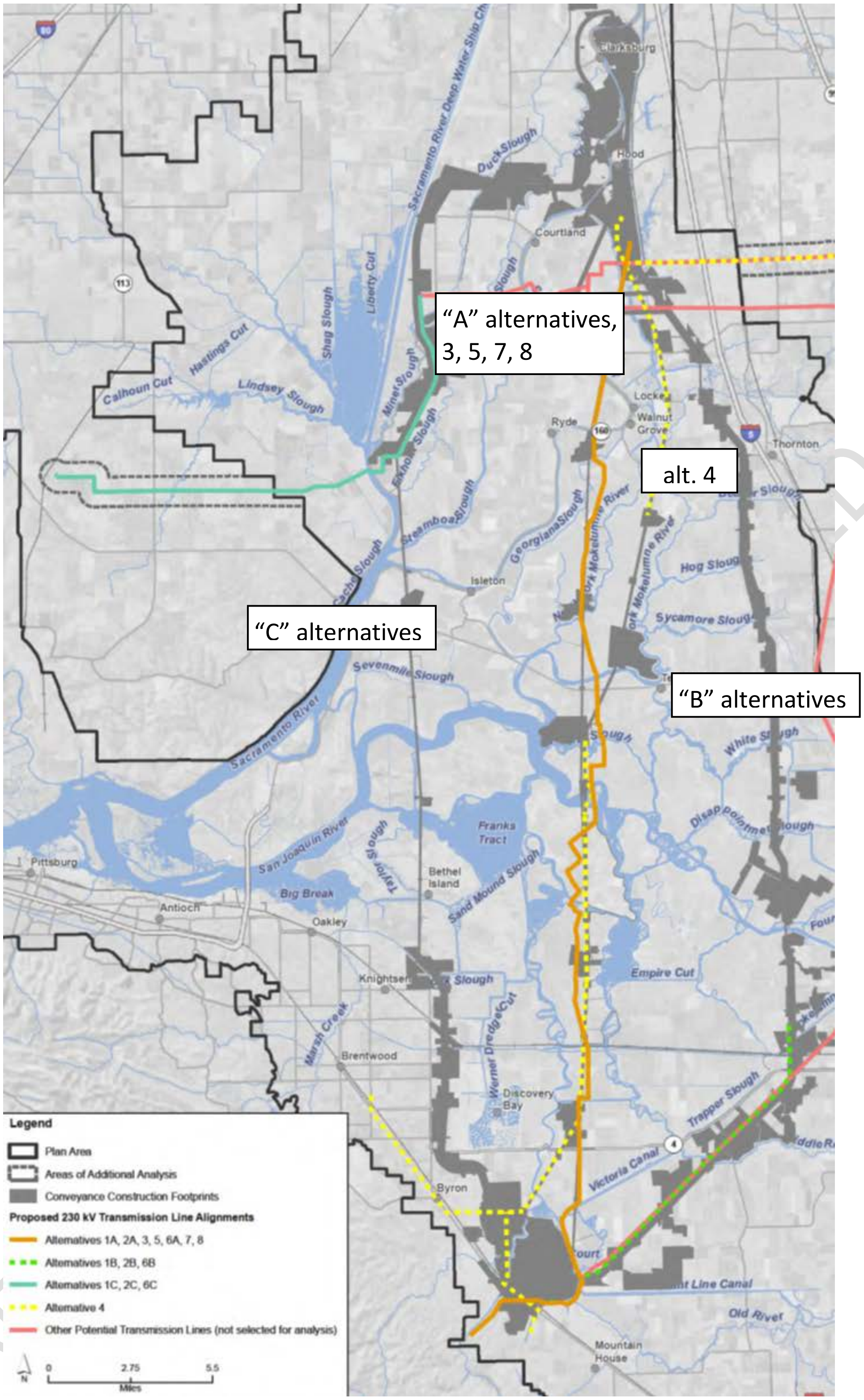

Figure 1: Conveyance Alignments for Alternatives 1-8 [needs redrafting]

Table 2. Summary comparison of conservation component acreages and variations among the alternatives (after Table ES-8 and Section 3.6.2)

<table>
<tr><th>Conservation Component</th><th>Variations</th></tr>
<tr><td>65,000 acres of restored tidal perennial aquatic, tidal mudflat, tidal freshwater emergent wetland, and tidal brackish emergent wetland natural communities within the BDCP ROAs (CM4).</td><td>Alternative 5, reduced to 25,000 acres. Alternative 9, expect different locations for restoration or enhancement activities.</td></tr>
<tr><td>10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta ROAs (CM5).</td><td>Alternative 7, expand to 20,000 acres of restored seasonally inundated floodplain fish and wildlife habitat, particularly along the San Joaquin River. Alternative 9, expect different locations for restoration or enhancement activities.</td></tr>
<tr><td>20 linear miles of channel margin habitat enhancement in the Delta (CM6).</td><td>Alternative 7, expand to 40 linear miles of channel margin habitat would be enhanced. Alternative 9, expect different locations for restoration or enhancement activities.</td></tr>
<tr><td>5,000 acres of restored native riparian forest and scrub habitat (CM7).</td><td rowspan="9">Alternative 9, expect different locations for restoration or enhancement activities.</td></tr>
<tr><td>2,000 acres of restored grassland and 8,000 acres of protected or enhanced grassland within BDCP CZs 1, 8, and/or 11 (CM8 and CM3).</td></tr>
<tr><td>Up to 67 acres of restored vernal pool complex and 72 acres of restored alkali seasonal wetland within CZs 1, 8, and/or 11(CM9), 600 acres of protected vernal pool complex within CZs 1, 8, and/or 11 (CM3).</td></tr>
<tr><td>1,200 acres of restored nontidal marsh within CZs 2 and 4 and/or 5, and the creation of 320 acres of managed wetlands (CM10).</td></tr>
<tr><td>50 acres of protected nontidal marsh (CM3).</td></tr>
<tr><td>150 acres of protected alkali seasonal wetland complex in CZs 1, 8, and 11 (CM3 and CM11).</td></tr>
<tr><td>1,500 acres of protected managed wetlands (CM3 and CM11).</td></tr>
<tr><td>5,000 acres of protected managed wetland natural community (CM3).</td></tr>
<tr><td>45,405 acres of cultivated land (non-rice) and up to 1,500 acres of cultivated land (rice) protected (CM3 and CM11).</td></tr>
<tr><td>Operable barrier (with boat lock) at the head of Old River would prevent returning and outmigrating salmon from entering Old River to minimize exposure to S. Delta pumping. Partially closed gate flow would pass through the fishway traversing a series of baffles.</td><td>Only for Alternatives 2A, 2B, 2C, and 4</td></tr>
</table>

Operating polices

The operational scenarios are described briefly below and in more detail in Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*.

- Scenario A (Alternatives 1A, 1B, 1C, and 3) includes: most No Action objectives for south Delta exports and required Delta outflow; new criteria for north Delta diversion bypass flows and assumed operations of the proposed Fremont Weir (notch) during high Sacramento River flows;but not Fall X2 objectives nor the SJR inflow/export ratio. The minimum bypass flow ranges from 5,000 to over 15,000 cfs, depending on time of year. Different north Delta diversion capacities influence the volume of pumping from the south Delta and overall Delta operations.
- Scenario B (Alternatives 2A, 2B, and 2C) include the Fall X2 criteria, but not the SJR inflow/export ratio. Scenario B would also include less negative OMR flow limits, and an operable barrier at the head of

Old River. All other No Action rules apply, and the north Delta intake bypass rules are as under Scenario A.

- Scenario C (Alternative 5) incorporates all the No Action rules and the north Delta intake bypass flow rules are as under Scenario A. The north Delta operations were limited because of a single 3,000 cfs intake on the Sacramento River.
- Scenario D (Alternatives 6) eliminates use of south Delta intakes and uses only the same north Delta intake bypass flow rules as Scenario A. Existing south Delta export rules would not apply, including the E/I ratio. All the No Action outflow rules apply.
- Scenario E (Alternative 7) modified Scenario A criteria for bypass flows, Fremont Weir gate operations, Rio Vista minimum flows, Delta outflow, and south Delta export operations.
- Scenario F (Alternative 8) modifies Scenario E to include specific Delta outflow criteria and cold water pool management criteria for specific reservoirs.
- Scenario G is similar to Scenario A, but is modified to conform to the conveyance as separate surface corridors for Alternative 9, without north Delta intakes. Instead, water continues to flow by gravity from the Sacramento River into two existing channels, Delta Cross Channel and Georgiana Slough, without North Delta Diversion Bypass Flow Criteria and Operations for Delta Water Quality and Residence Time. The Delta Cross Channel and Georgiana Slough gates would open only under higher flow conditions, with operable barriers on the Mokelumne River system as well.

Diversion restrictions include:

1) 2009 NMFS BiOp: San Joaquin River inflow/export ratio that limits combined exports based on the SJR inflows in April and May. Limits on reverse OMR flow in December–June of many years (adaptively managed based on fish monitoring).
2) Minimum monthly Delta outflows specified in D-1641 for each month, depending on the water year type (i.e., runoff conditions).
3) Maximum salinity objectives specified in D-1641 for each month or period for water users
4) Spring X2 location objectives introduced in the 1995 WQCP. X2, specified by month and (unimpaired) runoff in the previous month.
5) 2008 USFWS BiOp included an outflow requirement for September- November of wet and above normal water year types. Fall X2 rule requires X2 at or downstream of Collinsville in above normal years and downstream of Chipps Island in wet years.
6) State Water Board has recently explored additional operational rules that would require Delta outflow to be a specified percentage of monthly unimpaired flow.
7) North Delta bypass flows: July–September 5,000 cfs, October-November 7,000 cfs in all years. December–June allow bypass flows to increase with river inflow. Low-level pumping of 6% of the river flow would be allowed most of the time, but major diversions could not begin until the Sacramento River flow exceeds a specified threshold.

In-Delta barriers

The existing South Delta Temporary Barriers Project consists of seasonal installation and removal of three temporary rock barriers in Middle River near Victoria Canal, Old River near Tracy, and Grant Line Canal near Tracy Boulevard Bridge. These rock barriers are designed to act as flow-control structures, trapping tidal waters behind them following high tide. These barriers improve water levels and circulation for local south Delta farmers. A fourth barrier, installed at the head of Old River at the divergence from the San Joaquin River, is designed to improve migration conditions for salmon originating in the San Joaquin River watershed during adult and juvenile migrations, which occur annually in the fall and spring, respectively. In the fall, the head of Old River barrier improves downstream dissolved oxygen conditions; during the spring, the barrier is intended to prevent downstream migrating salmon smolt in the San Joaquin River from entering Old River. In 2009 and 2010, DWR installed and operated a nonphysical barrier at the head of Old River as an alternative to the spring rock barrier at this location. The nonphysical barrier uses underwater bubbles, light, and sound as a behavioral deterrent and tests the effectiveness of excluding outmigrating smolts from entering the south Delta via Old River without having to physically block the flow of water into the channel with a rock structure. In the future, DWR may install and operate the nonphysical barrier at the head of Old River as an alternative to the spring rock barrier.

Alternative 9 is a very different through Delta alternative with four separate flow corridors: (1) the north Delta separate water supply corridor that conveys water from the Sacramento River to Middle River; (2) the south Delta separate water supply corridor along Middle River and Victoria Canal that conveys water from San Joaquin River to Clifton Court Forebay; (3) the San Joaquin separate fish movement corridor that provides for fish migration from upper San Joaquin River to the lower San Joaquin River downstream of Franks Tract; and (4) the Mokelumne separate fish movement corridor that diverts from the Mokelumne River through Lost Slough and Meadows Slough to the Sacramento River. Two fish-screened intakes would be constructed: one each at the Delta Cross Channel and Georgiana Slough. Once in the channel, water would flow south through the Mokelumne River and San Joaquin River to Middle River and Victoria Canal, which would be dredged to accommodate increased volumes of water. Along the way, diverted water would be guided by operable barriers. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons, eventually reaching Clifton Court Forebay.

Alternative 9 includes the following water conveyance-related facilities.

- Operable barriers on the Mokelumne River near Lost Slough and on Snodgrass Slough near the Mokelumne River, extension of Meadows Slough to the Sacramento River, and installation of an operable barrier on Meadows Slough. These facilities would provide a path for fish migration from the Mokelumne and Cosumnes Rivers through Lost Slough and Meadows Slough to the
- Sacramento River, except during flood flows.
- On-bank diversions with fish screens at Delta Cross Channel and Georgiana Slough.
- A boat lock and channel at the diversion structure at Georgiana Slough.
- An operable barrier at Threemile Slough to reduce salinity in the San Joaquin River during low Delta outflow and potentially to reduce fish movement from the Sacramento River to the San Joaquin River.
- Operable barriers along Middle River at Connection Slough, Railroad Cut, Woodward Canal, and immediately downstream of Victoria Canal to isolate Middle River from Old River. Dredging would occur at each of these locations.
- Dredging along Middle River from Mildred Island to Victoria Canal and along Victoria Canal for a siphon to provide gravity flow into Clifton Court Forebay.
- Expansion and extension, through dredging, of Victoria Canal under West Canal, across Coney Island, and under Old River to Clifton Court Forebay.
- Intertie canal with a control gate between Clifton Court Forebay and the Tracy Fish Facility.
- Closure of the Clifton Court Forebay inlet gate from Old River except during flood flows.
- Closure of channel between Old River and the Tracy Fish Facility except during flood flows.
- Closure would include channel modification to allow continued access to River's End Marina from Old River.
- Operable barriers along the San Joaquin separate fish movement corridor at the upstream confluence of Old River and the San Joaquin River (head of Old River), Fisherman's Cut at False River, and Franks Tract to isolate Old River (San Joaquin separate fish movement corridor) from the San Joaquin River.
- A pumping plant on the San Joaquin River at the head of Old River to convey additional flows with organic material into Old River.
- A pumping plant on Middle River upstream of Victoria.

Table 3. Comparison of Operational Rules under BDCP Operational Scenarios and Alternatives (after Table ES-7)

Operational Scenario and Alternative	Months	No Action	A Alt 1	B Alt 2	A Alt 3	H Alt 4	C Alt 5	D Alt 6
New Operational Rules Controlling Maximum North Delta Intake Diversions								
Maximum Capacity of North Delta Intakes (1,000 cfs)	-	0	15	15	6	9	3	15
Bypass Flows (% of Sacramento River at Freeport)	Jan–Dec	O	X	X	X	X	X	X
Delta Operational Rules Controlling Maximum Allowable CVP and SWP South Delta Exports								
Physical/Permitted Limit for CVP (4,600 cfs)	Jan–Dec	All						
Physical Limit for SWP (10,300 cfs)								
SWP Article 21 Delivery (when San Luis Reservoir is Full)								
Available San Luis Reservoir Storage								
Seasonal CVP and SWP Delivery Pattern								
Permitted Limit for SWP (6,680 cfs plus 1/3 of San Joaquin River Dec 15–March 15)	Jan–Dec	X	O	O	O	O	X	O
Export/Inflow Ratio - S. Delta intakes only:	65% Jul–Jan, 35% Feb–Jun	X	Xa	Xa	Xa	Xa	Xa	O
SJR Inflow/Export Ratio	Apr–May	X	O	Ob	O	Ob	X	O
Reverse Old and Middle River Flows	Dec–Jun	X	X	Xe	X	Xe	X	O
Delta Operational Rules Controlling Minimum Required Delta Outflow								
Maximum Salinity (EC) for Delta Diversions	Jan–Dec	All						
Minimum Monthly Specified Outflow	Jan–Dec	X	X	X	X	X	X	X
Maximum Spring X2 Location	Feb–Jun	X	X	X	X	Xh	X	X
Maximum Fall X2 Location	Sep–Oct	X	O	X	O	Xh	X	X

1) Notes: "X" BDCP alternative incorporates this operational rule. "O" BDCP alternative does not incorporate that operational rule.
2) [a] In computing the E/I ratio for these scenarios, the Sacramento River inflow is considered to be downstream of the north Delta intakes, with the exception of Scenarios H2 and H4, for which Sacramento River inflow was assumed to be upstream of the proposed north Delta intakes.
3) [b] Under these scenarios, a different strategy was applied to achieve similar objectives as the SJR I/E ratio.
4) [c] SJR I/E ratio is applicable December through June and therefore would apply for five months longer than under the No Action Alternative.
5) [d] SJR I/E ratio is applicable when the San Joaquin River flow at Vernalis is greater than 10,000 cfs.
6) [e] More restrictive/protective than Scenario A.
7) [f] More restrictive/protective than Scenario B.
8) [g] More restrictive/protective than in the No Action Alternative; required Delta outflow is expressed as a percent of unimpaired flow.
9) [h] For Alternative 4, maximum Spring X2 Location will be determined based on the results of the decision tree process for spring outflow. Maximum Fall X2 Location will also be determined by the decision tree process under Alternative 4.

Chapter 4

I. Scope

This chapter describes the approach to the environmental analysis. It provides a clear description of the difference between CEQA and NEPA baselines.

II. Quality of Analysis

A. Three geographic regions are considered: upstream of delta, delta and SWP and CVP service areas. Areas downstream of the Delta (i.e., San Francisco Bay) were not included even though the NRC scientific review specifically stated this area should be included. Adequate justification for lack of consideration of impacts to San Francisco Bay was not provided in this chapter or elsewhere in the document, although there are potential impacts. For example, the expected reduction in sediment supply has the potential for impacts: 1) tidal marshes in the Bay could be less able to keep up with sea level rise, and 2) increased water clarity in the Bay could render it more responsive to nutrient inputs.
B. The chapter clarifies that the habitat restoration measures proposed are given only program level analysis for several reasons. Yet because of the uncertainty in location, implementation, and effectiveness of proposed restoration actions, the positive impacts of those actions that were considered as part of the BDCP EIR/EIS are highly uncertain. Hence the final assessment of net positive or no negative effect shown in the EIR/EIS is also highly uncertain.

III. Overall

The chapter does an adequate job of explaining the approach taken in the environmental analysis.

Chapter 6, Surface Water

This chapter deals with environmental consequences of potential surface water changes from disturbances introduced by BDCP conveyance and related facilities [CM1], operational facilities, conservation components [CM 2-22] and restored areas. The area examined is thought to be the most affected by SWP/CVP water supply operations and/or habitat restoration in the Delta and Suisun Marsh Restoration Opportunity Areas. Surface water in the Delta, upstream areas and in export areas also will be affected by the climate change and present/future projects. The changes affect the risks of floods, flow patterns, drainage, surface-ground water interactions and streams. The construction of facilities under BDCP would occur in the Sacramento/San Joaquin river basins, and the changes of SWP/CVP operations affect the flow in the Delta and upstream. Surface water of many SJR and SR tributaries as well as surrounding hydrologic basins, where conveyance is by pipes and canal systems, are unaffected. For each BDCP alternative, nine impacts are analyzed, and in some cases mitigation measures are identified to reduce adverse impacts on run off patterns, drainage, sedimentation, flooding, potential exposure and risks to people or structures. No action alternative also is considered.

Surface hydraulics in the BDCP area is complex, and is determined by circulation, transport, and mixing in Delta waters. The hydraulic network consists of over 700 miles of tidally influenced channels and sloughs, water supply facilities and about 18,000 diversions and 1,115 miles of (project and non-project) levees. The major forcing include freshwater flow into the Delta, tidal input from Pacific (as high as 600,000 cfs) and operation of water supply facilities. Sacramento River and Yolo bypass waters move south and westward is the primary contributor, followed by San Joaquin River flowing from the south. Pumping slows or reverses the flows that would naturally go north and west in the San Joaquin River (§5, §6 and §8). Operation of hydraulics structures has important tasks, including: elevating water surfaces for diversions, preventing fish from entering canals, and changing of circulation patterns.

Amongst myriad of impacts possible, most critical ones have been identified for the analysis, for example, SWP/CVP reservoir storage and related changes to flood potential, peak monthly flow in SR and SJR and reverse flows in Old and Middle river as a result of changing hydraulic characteristics. The existing conditions are compared with the year 2060 scenarios of No-action/No-project and BDCP alternatives with sea level rise and climate change (CEQA comparisons). Also compared are 2060 model conditions with BDCP alternatives that include climate change and no-alternatives with climate change only (NEPA comparisons). The surface water resources have been evaluated at project level if sufficient details are available, otherwise resorting to programmatic level analysis.

The effects analysis assumes reasonable thresholds to identify adverse effects under NEPA or a significant impact under CEQA, based on the number of months the reservoir is close to the flood storage capacity and peak monthly flows. Nine impacts (SW 1 to SW9) have been established and analyzed, and the results are placed in the framework of CEQA and NEPA effects.

II. Quality of Analysis

Commonplace modeling tools are used (CALSIM II together with ANN; DSM2 for water quality and particle tracking; CVHM hydrologic model), which are described in Appendix 5A. Also included therein are modeling assumptions, input parameters and additional information. Impacts [SW 1-9] for each alternative are addressed in a rigorous way. The following comments are offered for consideration by the preparer.

- The chapter involves a comprehensive and laborious study, and has identified a wide range impacts covering storage issues related to flood potential, peak monthly flows and flow reversals at critical locations. Related issues such as water quality, fish and aquatic resources and agricultural resources are addressed in other chapters. The inferences are almost entirely based on model outputs, but the reader is left to guess the uncertainties and how uncertainties affect these inferences, which are expressed in terms of 'no impact' and 'less than significant impact' etc. Uncertainties of complex models of the sort used here can be unacceptaby high, model calibrations leave much to be desired (see Kimmerer et al. *San Francisco Estuary & Watershed Sc*., Feb 2008) and inter-comparisons of different models are scarce (NRC 2012). Some recent references to model testing, if available, may help. CALSIM III has better capabilities for ground water-surface water interactions and disaggregation of demand units, and it would be useful to know whether the conclusions made would change if it is used.
- Flow-salinity relationships in Delta are evaluated using DSM2, which is linked to the neural network ANN to evaluate whether certain salinity requirements are met. The training of ANN is based on the current data, and the relationships so obtained may not be applicable to future scenarios with modified flow structures. In addition, DSM2 is a one dimensional model and has inherent limitations in simulating open water areas, flow in bends and small channels as well as inlet/outlets. The Delta circulation patterns, which are strongly influenced by horizontal mixing, diversions and freshwater input, therefore may not be adequately simulated by the modeling system used.
- Tidal energy coming from outside the Golden Gate is another limited resource in the development of habitat in the Delta and its larger estuary. A major effect of many of the proposed habitat restoration activities (as well as potential island failures in the future) is likely to be the changes in tidal amplitude and mixing. This will affect the suitability of certain characteristics for restoration. It will reduce mixing of inland and coastal waters and high-tide related flooding in the Delta. This aspect needs further consideration.
- Little is mentioned about the role of adaptive management, although development of hypotheses within the framework of complex BDCP alternatives would be difficult. Any information in this regard can be helpful.
- It is assumed that the alternatives would modify the operations of SWP/CVP facilities but not the facilities owned and operated by other water rights holders. Thus, the surface waters of many Sacramento and San Joaquin river tributaries are assumed to be unaffected (§6.3.1). Naturally, one would expect changes to the modus operandi of other owners in response to potential changes due to BDCP alternatives. Similarly, changes in flow regulations for environmental and water quality objectives into the distant future are not examined or discussed (and would be difficult to examine). No analysis or statement regarding such feedbacks is given.
- It was determined that estimating peak flows in a sub-monthly time step based on monthly flows of CALSIM II would not be reliable for flood risk analysis. Can HEC-RES-SIM or other modeling systems with higher temporal resolution be used in this regard?
- The list of communities subject to flooding does not include Bethel Island, a community of a few thousand on a fairly deeply subsided island (p. 6-21).
- Chapter 6 considers how the Plan and its alternative may affect levees. It provides a lucid summary of levees as essential and vulnerable in flood control (p. 6-11 to 6-18). It also analyzes potential near-term damage to levees from construction of water-conveyance facilities (impact SW-7) and from creation of subtidal habitat (SW 8). Other

parts of the draft EIR/EIS consider how Delta levees affect other resources. Levees are described as vital to water supplies under current conditions (p. 5-61 to 5-64; p. 3E-16 to 3E-18). By corollary, levees remain important under most of the action alternatives, both for water supplies and for ecosystem restoration. A comprehensive levee chapter would bring these issues together. Its summary would compare alternatives by their expectable effects on levee maintenance, not just during and soon after construction, but also on a 50-year timescale.

I. Overall Assessment

Overall the chapter is innocuous, uses canonical tools and standard inference methods. The reason for selection of particular tools over available alternatives is not identified. Significant potential impacts are predicted for many BDCP Alternatives under categories SW 4-6, and mitigation measures are proposed. It is not clear why no determination has been made on the impacts of reverse flow conditions in Old and Middle Rivers under BDCP alternatives, although Chapter 6 lays out many of the impacts for each alternative; a clarification is needed.

The existing summaries of Chapter 6 are limited to tabular entries in the Executive Summary and brief text in the Highlights Brochure. The table identifies nine surface-water impacts (p. ES-61 and ES-62), and the highlights text offers four bulleted paragraphs (p. 21 of BDCP_highlights.pdf).

Like most of the rest of the draft EIR/EIS, Chapter 6 still lacks an informative summary of expected impacts of the no-action and action alternatives. It contains no up-front analysis that succinctly compares the alternatives: no-action vs. actions, certain kinds of actions vs. other kinds of actions. It also offers no summary by impact, in contrast with Chapter 12 (terrestrial biology; p. 12-5 to 12-31). Chapter 6 still needs cogent analysis of how the proposed Plan (alternative 4) stacks up against alternatives in terms of effects on, and effects of, surface water.

Chapter 9, Geology

Chapter 9 makes a murky case for its plausible conclusion that the proposed BDCP actions won't add much to existing geologic risk. The scientific basis for this conclusion is clouded by problems summarized in the table of contents below. Also mentioned in this review are potential scientific benefits that the chapter overlooks.

IMPACTS CONSIDERED

Geology affects the Delta as both resource and threat. Geology comes into play as a resource where including aquifers (Chapter 7), forming parent materials for agricultural soils (Chapters 10, 14), providing aggregate or natural gas (Chapter 26), and containing fossils (Chapter 27). The geologic threat mentioned most in the draft EIR/EIS is earthquake-induced failure of Delta levees (p. 1A-8 to 1A-9; 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18).

Chapter 9, a "resource chapter," assesses geology as a threat to persons and property. The chapter enumerates, for impact assessment, the 16 threats listed in summary Table ES-9 as GEO-1 to GEO-16 (p. 66-67). Most are tied to earthquakes. Five of the potential impacts would occur during construction of water-conveyance facilities under conservation measure CM-1 (GEO-1 to GEO-5); another six during operation of these facilities (GEO-6 to GEO-12); and the remainder in association with habitat restoration efforts (GEO-13 to GEO-16).

As summarized in Table ES-9, the CEQA impacts are "less than significant" both before and after mitigation for all 16 threats under all the action alternatives. The table rates the no-action alternative as having three potential impacts that are "beneficial."

CONCERNS

Narrow assessment of levee failure

Though Delta levees figure abundantly in the EIR/EIS as a Delta resource, no resource chapter addresses impacts to levees comprehensively. Delta levees are presented as vital to water supplies (p. 3E-16 to 3E-18, 4-9, 5-61 to 5-64, 29-19 to 29-20) and to flood control (p. 6-11 to 6-18), and the threat of levee failure is cited as a reason the BDCP is needed (p. 2-3, 31-5). Yet formal assessment of levee-related impacts appear limited to Chapter 6 (surface water) and Chapter 9 (geology). These chapters ask whether the construction and operation under the various action alternatives would increase changes of levee failures from floods and earthquakes. The geology chapter limits its consideration of levees to the immediate vicinity of facilities at or near the ground surface. No chapter considers two broader effects: how Delta levee failures would affect water operations under the various alternatives (summarized p. 29-19 to 29-20); and how the various alternatives would affect the economics of maintaining Delta levees.

A comprehensive assessment of levee-related impacts would treat them more broadly. It would ask how levee failures would affect each alternative in terms of water supplies and ecosystem health. It would also explore how each alternative may affect incentives and funding for levee maintenance, and it would evaluate each alternative in light of the climate-change impacts (sea-level rise, extreme floods) discussed on pages 29-19 and 29-20. The broadened assessment would consider the non-action and action alternatives in light of recent reports about Delta levees. These include discussions of hazards to Delta levees (Mount and Twiss, 2005; URS Corporation and Jack R. Benjamin & Associates Inc., 2008; Brooks et al., 2012) and of strategies for risk reduction (Suddeth et al., 2010; URS Corporation and Jack R. Benjamin & Associates Inc., 2011; Bates and Lund, 2013)

Debatable choices about levels of significance

The draft EIR/EIS estimates that the action alternatives would have "less than significant" impact on the potential for death, injury, or property loss from earthquakes and their effects. This assessment applies both before and after mitigation according to the summary table (p. ES-66 and ES-67). Safeguards built into engineering design and construction practices are expected to prevent "an increased likelihood of loss of property, personal injury or death of individuals (example, p. 9-53 to 9-54).

Chapter 9 does not appear to factor a background threat of levee failure into these reasonable conclusions. The chapter summarizes this threat in section 9.3.3.1.1 (p. 9-49 to 9-50), and the threat looms in other parts of the draft EIR/EIS as well (p. 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18). In a further instance, a water-supply assessment cites the threat of earthquake-induced levee failures that could flood as many as twenty Delta islands at once (p. 5B-12). The impact assessments in Chapter 9 do not appear to consider action alternatives in combination with levee failures unrelated to the actions. Would these combinations result in any increased likelihood of losses to persons or property?

The tabular summary of potential impacts on pages ES-66 and ES-67 can be misread as implying that benefits assigned to the no-action alternative do not extend to the action alternatives. The benefits are derived from "ongoing plans, policies, and programs" that seem largely independent of the BDCP (p. 9-50 to 9-51).

Indefinite plan for assessing liquefaction hazards

Liquefaction, in which pore-water pressure lowers the strength of granular material, is the main process by which earthquakes are likely to cause levee failure in the Sacramento - San Joaquin Delta (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The liquefiable materials may be within a levee, beneath the levee, or both. The modes of resulting damage may include sliding, settlement, cracking, and groundwater eruption. Unlike localized breaches in the Delta's written history, the failures associated with future liquefaction may extend along levees for hundreds of meters. These concerns provide ample justification for the sections in Chapter 9 accordingly that consider liquefaction hazards to Delta levees.

Chapter 9 provides little information, however, about the basis for its liquefaction analyses. Such analyses commonly begin with borehole data like that in Figure 9-4. The chapter states that the analyses will use "available soil data from the [Conceptual Engineering Reports]" of proposed BDCP conveyance alignments (p. 9-46). Those reports are listed on pages 9-1 and 9-2, but they do not appear to be available online.

Subsquent steps are summarized in a one-paragraph statement of approach (p. 9-70). The approach appears to follow the so-called "simplified procedure" that engineers routinely use in liquefaction-hazard assessment. This procedure originated over 40 years ago (Seed and Idriss, 1971) and was updated in the last decade (Idriss and Boulanger, 2008).

Uncertainty not mentioned in Chapter 9 surrounds current implementation of the "simplified procedure" of Seed and Idriss (1971). Competing curves relate the occurrence or non-occurrence of liquefaction to material properties and ground motions (Idriss and Boulanger, 2010; Seed, 2010). The matter is under study by a National Research Council committee (http://www8.nationalacademies.org/cp/projectview.aspx?key=49573).

Even if this uncertainty is set aside, Chapter 9 appears deficient in details on how liquefaction-hazard assessment under BDCP will be carried out. Such details appear to await "final facility designs" in which "site-specific geotechnical and groundwater investigations would be conducted to identify and characterize the vertical (depth) and horizontal (spatial) extents of liquefiable soil" (p. 9-70).

A reviewer may reasonably wonder whether the liquefaction part of the impact assessment is to be carried out at the project level or the program level. An overview on page 3-22 states that project-level assessments are provided for conveyance facilities (CM1), while program-level assessments are made for other actions. Whatever the case for liquefaction, its assessment seems part of a mitigation measure for preventing any increase in the "likelihood of loss of property, personal injury or death of individuals" (example, p. 9-53).

Neglect of other clues to liquefaction risk

Comprehensive assessment of liquefaction risk to levees in the Delta and the Suisun Marsh was central to the Delta Risk Management Strategy (DRMS) study discussed in the next section (p. 16). The assessment was based in part on application of the "simplified procedure" of Seed and Idriss (1971) to borehole data from Delta levees. The assessment also took account of the steepness of levee banks. The products include maps of the Delta and Suisun Marsh that show the distribution of potentially liquefiable sand beneath levees, the presence of sand within levees, and the levee-failure vulnernability in three generalized categories ((URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Figs. 6-35, 6-36, and 6-37). The sand beneath levees was found most widely liquefiable in northern and southeastern parts of the Delta, areas that include proposed BDCP conveyance facilities.

Chapter 9 appears to say nothing about these findings. As its leading example of liquefaction-hazard mapping the chapter instead uses findings from the year 2000 (p. 9-22, Fig. 9-6). These findings were not built into DRMS because "all aspects of that analysis, the seismic hazard model and, the fragility analysis are out of date" and because several principals in the 2000 work advised against using it (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. B, p. 6-1). The depiction of hazard in Figure 9-6 contrasts with that by the DRMS study. For instance, Figure 9-6 of Chapter 9 shows all Sherman Island levees as having high potential for damage from liquefaction, while DRMS Figure 6-37c assigns a majority of Sherman Island's levees to the lowest of three categories of vulnerability to earthquakes (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

The liquefaction map in Figure 9-6 also neglects a common approach to sketching liquefaction hazard on a regional scale. As illustrated by damage to railroad bridges by the 1964 Alaska earthquake (McCulloch and Bonilla, 1970), the abundance and severity of liquefaction commonly varies with the age and depositional environment of geologic materials. Geologic maps may thus be transformed into liquefaction-susceptibility maps (Tinsley et al., 1985; Holzer et al., 2009).

In the Delta, mapped geologic materials of greatest concern for liquefaction are the sand and silt that accumulated in stream channels during recent millenniums. Some of these form ribbons of potentially liquefiable material that extend beneath Delta levees. Many such ribbons have been delineated from historical maps and from interpretation of aerial photographs (Atwater, 1982; Whipple et al., 2012).

Also of potential concern is wind-deposited sand that extends into most of the Contra Costa County part of the Delta. Chapter 9 mentions these geologic materials (p. 9-4 to 9-8) and identifies them as "liquefiable during major earthquakes" (p. 9-69).

Reliance on a superseded assessment of seismic hazards

Chapter 9 makes abundant use of a draft report from the Delta Risk Management Strategy (DRMS) study cited above. This study included a comprehensive seismic-risk assessment of seismic risk to levees of the Delta and Suisan Marsh. The risk assessment study, runs 270 pages as section 6 of the final report issued in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A 2007 draft (URS Corporation and Jack R. Benjamin & Associates Inc., 2007), underwent abundant revision after critical review (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. A, B). Chapter 9 uses only the 2007 draft, which it typically calls "the seismic analysis" and cites as "California Department of Water Resources (2007a) and as "DWR (2007a)." Among text and tables in Chapter 9 are about 85 such citations in all.

This situation leaves the reader wondering whether use of the final 2008 report, instead of the 2007 draft, would change the impact assessment in Chapter 9. A spot check of Tables 9-7 and 9-11 shows minor differences with entries in the corresponding tables in the 2008 DRMS report (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Tables 6-1 and 6-5, respectively). A fuller assessment of the impact of the obselete DRMS version is beyond the scope of this review.

Chapter 9 recently went out of date in its citations about probabilistic estimates of earthquake shaking in California. The earthquake probabilities cited on page 9-10 were estimated more than a decade ago by the 2003 Working Group on California Earthquake Probabilities. The 2007 group released an updated assessment as Uniform California Earthquake Rupture Forecast 2 (Field et al., 2009). Table 9-12 (p. 9-21) effectively cites this assessment by referending the related 2008 version of the USGS national seismic hazard maps. But a rigorously up-to-date version of Chapter 9 would have mentioned a further iteration, UNCERF3, that was released in part in November 2013 (Field et al., 2013), in preparation for the 2014 national update.

Carelessness with assertions and references

"These organic soils [the peat of tule marshes] formed from accumulated detritus of the tules and other vegetation." (p. 9-3)—Tidal marshes and tidal swamps aggrade by trapping sediment that tides bring in and by retaining organic matter that the wetland plants produce on site. The retained organic matter includes roots and below-ground stems (rhizomes) that the plants inject into wetland soils (Nyman et al., 2006; Mudd et al., 2009; Kirwan et al., 2010; Miller and Fujii, 2010; Takekawa et al., 2013, p. 10-11).

"It was necessary to use different sources to compile the geologic map" (p. 9-3)—A new source not mentioned is mapping by Sowers et al. (2013). An example of this mapping, along the Sacramento River south of Sacramento, was presented as a poster at the 2010 Bay Delta Science Conference.

"the text descriptions [of geologic map units] are taken directly (i.e., verbatim) from the work done by Graymer et al. (2002) because this work...provides the most recent and relevant general descriptions of the geologic units that occur in the Plan Area" (p. 9-3)— This compiler's choice is a debatable one. The Delta makes up less than 1/6 of the map area of Graymer et al. (2002), and barely 1/3 of the Delta lies within that map area. A Graymer map name adopted on page 9-4, "Delta mud deposits," poorly describes deposits that are dominated by peat in the central Delta. The associated description of Delta peatland as lowered by "compaction and deflation" misrepresents subsidence that owes more to decomposition (p. 10-11 to 10-12) (Deverel and Leighton, 2010).

"This correlation [of geologic names used on two different maps] is only an approximation provided by the chapter author to aid the reader. It is not a scientific or peer-reviewed analysis." (p. 9-4, 9-6, 9-7, 9-8)—Disappointing

"in 1935 the University of California Agricultural Experiment Station mapped the surface soils" (p. 9-4)—The work perhaps alluded to here, without citation, is the classic Delta-wide soil survey by Cosby (1941).

"The Delta and Suisun Marsh are in...one of the most seismically active areas in the United States" (p. 9-10)—Seems add odds with another statement on the same page: "...the San Francisco Bay Area and Delta region have generally experienced low-level seismicity since 1800."

"tsunami inundation area on the shores of the Sacramento River" (p. 9-25)—The statement apparently refers to Carquinez Strait.

"Peak acceleration response at a period of zero seconds or PGA is also widely used to characterize the level of ground motion." (p. 9-45)—Peak ground acceleration is conventionally defined as "maximum acceleration experienced by the particle during the course of the earthquake motion" without respect to frequency (http://eqint.cr.usgs.gov/parm.php).

"With respect to the hazard of a seiche, the existing water bodies in the Delta and Suisun Marsh tend to be wide and shallow." (p. 9-50)—Disregards channels

"levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (p. 9-50, reiterated p. 27-22)—This unreferenced statement appears to be taken verbatim from a DRMS report; it appears on page 6-37 of the final seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A more nuanced statement would cite this report's Figure 6-35 as evidence that liquefiable foundations, identified through geotechnical borings, are most common in northern and southeastern parts of the Delta. In a further nuance worth mentioning: for the 1906 San Francisco Earthquake, "calculations indicate that small to moderate damage would have occurred if the levees were at today's configuration during the 1906 event" (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, p. 6-36).

Chapter 9 cites large reports without pointing the reader to specific pages or figures within them. A more rigorous assessment would cite by chapter and verse.

The reference list for Chapter 9 excludes not just the final DRMS reports (URS Corporation and Jack R. Benjamin & Associates Inc., 2008; URS Corporation and Jack R. Benjamin & Associates Inc., 2011) but also a prominent update on procedures for assessing liquefaction hazards (Idriss and Boulanger, 2008) and an authoritative review of Delta subsidence (Deverel and Leighton, 2010).

Lack of summary

Like most of the rest of the draft EIR/EIS, Chapter 9 lacks an informative summary of expected impacts. The chapter's existing summaries are elsewhere, and they are limited to tabular entries in the Executive Summary and to watered-down text in the Highlights Brochure.

The chapter needs a summary, pitched to specialists but accessible to others, that would build on the entries on pages ES-66 and ES-67, and on the text on Highlights pages 26 and 27. The summary would make clearer how the various alternatives, including the no-action alternative, compare with one another in terms of effects on geology as a threat (and perhaps also as a scientific resource). Included would be an analysis of how the preferred CEQA alternative compares with the no-action alternative.

The Executive Summary of the draft EIR/EIS could tabulate the Chapter 9 impacts more clearly. Each of the three groups of potential impacts shares identical text that could be gathered in header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

Benefits overlooked

A CEQA guideline recommends assessing impacts that would "Directly or indirectly destroy...a unique geologic feature." Another CEQA guideline asks, "Does the project have the potential...to eliminate important examples of the major periods of California history or prehistory?" (http://ceres.ca.gov/ceqa/docs/Adopted_and_Transmitted_Text_of_SB97_CEQA_Guidelines_Amendments.pdf)

Chapter 9 might thus consider, as incidental benefits of BDCP action alternatives, geologic discoveries along routes of proposed tunnels and canals. Such discoveries may provide long-term context for 21st-century questions about climate change and ecosystem restoration (Malamud-Roam et al., 2006; Canuel et al., 2009). Precedents include incidental use of bridge-foundation borings as guides to sea levels and marsh accretion at San Francisco Bay (Trask and Rolston, 1951; Atwater et al., 1977).

Borings for proposed BDCP tunnels are already providing insights into prehistoric volcanic eruptions. The borings have sampled volcanic ash layers that erupted about 400,000 years ago near Bend, Oregon, and about 600,000 years ago near Mount Lassen, California (Maier et al., 2013). Widespread volcanic-ash layers are important to geologists not only as signs of catastrophic hazards but also as unique tools for assigning, to the same instant in geologic time, climatic and tectonic events in widely separated places (Sarna-Wojcicki et al., 1983; Sarna-Wojcicki et al., 1985). Such scientific use of BDCP geology would complement the engineering application of the findings in Figure 9-4.

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Chapter 10, Soils

Chapter 10 concludes that the proposed BDCP actions would cause significant harm to farmland soils by burying some beneath construction spoil and by inundating others in habitat-restoration areas. The chapter also determines that the soils pose little threat to the BDCP actions. These plausible findings are undercut by inadequate summaries, missing references, and minor inaccuracies.

IMPACTS CONSIDERED

Chapter 10 treats soils both as agricultural resources and as construction hazards. In five of the nine soil impacts considered, the question is how an action (or inaction) will affect soils by means of erosion or decomposition. In the four other impacts, the soils pose potential hazards to people and facilities.

With four exceptions, the CEQA impacts for all options are termed "less than significant" both before and after mitigation (p. ES-67 to ES-68). In two of the exceptions, the no-action alternative is called "beneficial" because of non-BDCP efforts to arrest subsidence from decomposition of peat (SOILS-3, SOILS-8). In the other exceptions, topsoil is lost to decomposition under the non-action alternative, to burial under spoils from construction of conveyance facilities, and to inundation from habitat restoration (SOILS-2, SOILS-7).

Not included among assessed impacts assessed is soil loss from unintended flooding. Lasting losses may be limited to scour ponds and their aprons if levee breaches are repaired. On islands left permanently flooded the losses are of course greater.

CONCERNS

Inadequate summaries

Like most of the rest of the draft EIR/EIS, Chapter 10 needs to begin with an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and brief text in the Highlights Brochure. The table enumerates nine soil-related impacts (p. ES-67 and ES-68), and the highlights text describes soil losses as a BDCP impact (p. 28 of BDCP_highlights.pdf).

A useful summary, placed at the outset of Chapter 10, would quantify losses and relate them to the non-action and action alternatives. For instance, a table similar to the one on page 39 of the Highlights Brochure would itemize losses of agricultural soil from burial by tunnel waste, exavation of canals, and intentional breaching of levees. The table and associated text would analyze action alternatives by broad category, as done effectively in the Chapter 12 summary.

The summary would make clear, quantitatively, how the various options, including the no-action alternative, stack up in terms of effects on and of the soils. The summary might show, for instance, that the tunnel alternatives would cause fewer losses to certain kinds of agriculturally important soils than would the canal alternatives.

The existing Highlights text conflates landforms and soils in a confusing fashion. This text should conform more nearly to the Chapter text, which creates no such confusion (p. 10-3 to 10-6).

The Executive Summary of the draft EIR/EIS could tabulate the Chapter 10 impacts more clearly (p. ES-67 and ES-68). The impacts form two groups: SOILS-1 to SOILS-5 on conservation measure CM1, SOILS-6 to SOILS-9 on other conservation measures. Each of the two groups of potential impacts shares similar or identical text that could be gathered in header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

The tabular summary on pages ES-67 and ES-68 could distinguish more clearly between no-action and action alternatives in terms of no-action impacts that also apply to proposed BDCP actions. Under impacts on subsidence, the summary presents the no-action alternative as beneficial because of subsidence-reserval projects independent of the proposal BDCP actions, without applying this benefit also to the proposed BDCP actions. Similarly, "significant" soil loss, under the no-action alternative, if caused chiefly by decomposition of peat, would seem to extend to the proposed BDCP actions.

References missing

p. 10-2, lines 35-38—This summary of geological history, referenced to a report from 1950, exaggerates the roles of Carquinez Strait and inorganic sediment in building the historical channels and tidal wetlands of the Delta. Chapter 9 cites additional, newer references that could help here.

p. 10-3, lines 20-21—Could also cite the classic survey by Cosby {{1863 Cosby,S.W. 1941/a;}}.

p. 10-4, line 4—According to this generalization from 1950, peat with many rhizomes of *Phragmites australis* [the current species name for this reed] underlies peat with many rhizomes of *Schoenoplectus acutus* and *S. californicus* [the current names for the main bulrushes]. Subsequent work has not reproduced this finding (Atwater, 1982; Drexler, 2011).

p. 10-4, footnote 1—The most up-to-date, reliable source on peat thickness is Deverel and Leighton (Deverel and Leighton, 2010, p. 8). The 2007 California Department of Water Resources reference cited in the footnote is an obselete draft of a report finalized in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

p. 10-10, lines 16-17—Prefer Galloway et al. (1999) as comprehensive and technically sound, as well as written and illustrated for broad audiences

p. 10-11, lines 6-21—A standard reference not cited: Thompson (1957).

p. 10-11, line 24—Update to Deverel and Leighton {{3237 Deverel,S.J. 2010/a;}}.

Other points

p. 10-2, lines 2-3 and 31-33—Distinguish between "soils" in the agricultural sense and "soils" as used by engineers.

p. 10-3, line 33—This summary could identify the soils of modern tidal wetlands and compare them to the diked and drained soils of former tidal wetlands. Likewise for the summary of Suisun Marsh soils on page 10-4, lines 20-22.

p. 10-5, line 16—The heading "Valley Fill" is potentially confusing because it brings to mind Sacramento Valley, San Joaquin Valley, Central Valley.

p. 10-11, line 1—N ow *Schoenoplectus acutus* and *S. californicus.*

p. 10-11, line 5—Is this peat depth residual (after subsidence) or original (ca. 1850)?

p. 10-12, line 42—The current rates of subsidence vary with substrate. The rates are probably zero in the large part of Jersey Island where Pleistocene dune sand is exposed at the ground surface. An important point that bears on restoration opporunities in other parts of the Delta where mineral soils have already been exhumed; these areas can't subside further by decomposition of peat. This issue reappears on page 10-26, beginning on line 32, with a section that describes subsidence from decomposition of organic soils as continuing "to varying degrees." The section does not describegeographic differences. A fuller description would identify the west-central Delta as the main area where mineral soils are not widely exposed.

10-13, line 17—This section could be expanded to discuss consequences of arresting or reversing subsidence. A supporting reference: Miller and Fujii (2010). The discussion would help anticipate the benefit identified on page 10-26, line 40.

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Chapter 11, Fish and Aquatic Resources

Conclusions

Overall the EIR/EIS could demonstrate a more balanced approach by fully discussing results from an ecosystem perspective (to add to the species-by-species discussions), fully embracing uncertainty and discussing it uniformly while distinguishing knowns from unknowns, and explicitly stating assumptions and differentiating conclusions from hypotheses. The detailed piece-by-piece and part-by-part treatment of CMs and species, although perhaps necessary, dilutes the merit of the overarching ecosystem perspective of the intent of this plan. Success will depend on a fully functioning system and analyses that incorporate integration across species, within a species, and across regions. Adaptive management will require a well-planned and comprehensive research and monitoring program that will target causality and test Plan hypotheses.

Our specific concerns with this chapter of the EIR-EIS include: (1) positive benefits of habitat restoration are highly uncertain, and if not realized, will invalidate the final conclusion of no net negative effect; (2) further analysis of effects of flow on entrainment is needed; (3) the decision-tree process is not adequately described; (4) interactions and synergies among species and the potential impacts on other ecologically important species are not adequately considered; (5) the qualitative nature of the effects analysis makes results more aligned with 'hypotheses' rather than 'conclusions' or 'predictions'; (6) full life cycles are not adequately considered; (6) a more complete description of adaptive management is needed; and (7) uncertainty in the conclusions is not adequately acknowledged throughout the EIR-EIS.

Chapter aims and scope

This extensive and comprehensive chapter evaluates impacts of construction, maintenance, and operation of each of the alternatives of Conservation Measure (CM) 1 and many of the other conservation measures on fish and other aquatic resources. Impacts on 20 fish species are evaluated. Eleven <u>covered</u> fish species that are federally threatened or endangered (Delta smelt, longfin smelt, Sacramento splittail, fall-, winter-, and spring-run Chinook salmon, steelhead, green sturgeon, white sturgeon, Pacific lamprey, and river lamprey) are discussed separately for each of the alternatives and most CMs, often for multiple fish life stages. The 9 <u>non-covered</u> species that are California Species of Concern or of recreational and/or commercial importance (striped bass, American shad, threadfin shad, largemouth bass, Sacramento tule perch, Sacramento perch, Sacramento-San Joaquin roach, hardhead, and California bay shrimp) are discussed collectively. In addition, impacts of CM 1 and alternatives on other coldwater habitat species in upstream reservoirs are also evaluated.

As stated in Chapter 11, the actual effects of the actions are dependent on a clear understanding of Chapter 5 (the Effects Analysis) in the Draft BDCP. For example, "The methods used to analyze impacts to covered and non-covered fish and aquatic species in Chapter 11 rely on the models and data included in the Effects Analysis……An understanding of the Effects Analysis will help inform a review of Chapter 11. In some instances, the description of fish species life stage timing and distribution varies between the Effects Analysis and EIR/EIS. These differences are in the process of being updated to match one another….” (p. 11-2)

Sixteen of the 22 CMs are dealt with in detail for each of the covered species. These can be summarized as impacts as a result of the construction, maintenance and operations of the new water conveyance systems (CM 1), impacts from habitat restoration efforts, (principally CM 2 and CM 4 but also CM 5, CM 6, CM 7 and CM 10) and those individual activities (CM 12 – CM 19 and CM 21) that are designed to “reduce the direct and indirect adverse effects of other stressors on covered species”. The latter include reductions in predators, illegal harvest, and invasive vegetation, and enhancement of hatcheries for some species, installation of nonphysical fish barriers, and improved oxygen conditions in the Stockton Deepwater Fish Channel.

In essence, a simplified summary of the primary projected impacts of the EIR-EIS are;

1) The construction, maintenance and operation of a new water conveyance system could change downstream flow rates and could have negative impacts on some species. However, the new conveyance system will allow additional flexibility in flow control that may improve resilience to climate change and may reduce fish entrainment losses by shifting intake usage between North and South intakes based on fish abundances in the area.
2) Habitat restoration, including flood plain inundation, may increase physical habitat area and food production for covered species via increased phytoplankton production.
3) Targeted activities will attempt to reduce predators, control invasive species, reduce illegal harvest, and be beneficial to certain species in various ways.

There were also several mitigation measures proposed to minimize the biological effects of construction and maintenance activities. In many cases it is argued that any negative impacts caused by changes in outflow would be fully compensated for by other conservations measures, principally habitat restoration.

Areas of Concern

The DISB review focuses on overarching major points concerning the scientific approach.

POINT 1: Effectiveness of Habitat Restoration

A fundamental component of the overall program is the success of comprehensive habitat restoration and connectivity. If proposed habitat restoration actions are not implemented or are not as effective as assumed in the EIR-EIS, then the positive impacts of those actions would no longer be present, and the final assessment of a net positive or no net negative effect would not be valid. A key uncertainty that has a profound impact on the assessment of impacts is the extent, timeliness, and effectiveness of the protection and restoration actions, particularly restoration of tidal marshes and floodplains (including the Yolo Bypass).

Extent

Specific sites for restoration activities have not been determined, nor has their ability to pass environmental review requirements been assessed. If willing land-sellers are not found or if environmental problems are identified (e.g., excess methyl mercury production), then those preservation and restoration actions and the positive benefits attributed specifically to them in the impact analysis would not occur. Likewise, the analysis of changes in hydrodynamics with new intakes and habitat restoration are central to evaluation of the effects on fishes. Yet the hydrodynamic analysis is based on one possible configuration of habitat restoration, and if that is not the final configuration, the results of the hydrodynamic analysis could change. The sensitivity of conclusions to the configuration of habitat restoration should be evaluated in the EIR-EIS.

Timeliness

Construction and flow operations may have impacts immediately, whereas the restoration impacts and benefits may lag a decade or more after construction. Often it is claimed that the negative impacts in one area (e.g., flow changes on covered species) can be compensated for by habitat restoration. Analyses suggesting this result are often based on the implicit assumption that the new habitats are 100 % effective and fully functional ecosystems that are tightly integrated physically and biologically with the rest of the Delta. The literature strongly suggests, however, that there are significant time lags between construction of a new habitat and its full functionality. This means that the benefits of habitat restoration may not occur for a long time and that the benefits may be too late for some species if negative impacts come first. These time lags were not fully considered in the EIR-EIS. The effect of time lags on overall conclusions should be evaluated in the EIR-EIS. Alternative scenarios should be considered in which habitat restoration begins sooner or is phased in to maximize the benefits (e.g., by starting with habitats that will have the largest impacts). The priority of habitats to be restored is not indicated, so it is not clear if the most critical habitats will be first on the list.

Effectiveness

Even if all acres are acquired and restoration actions are taken in a timely manner, whether those actions will deliver the anticipated benefits or not is also uncertain. For example, the analysis regarding habitat restoration assumes there will be increases in phytoplankton production and that these increases will be transferred up the food web to covered species. This largely ignores an equally likely result that the added biomass of phytoplankton will be consumed by clams, which have had substantial effects on phytoplankton abundance and species composition throughout the Delta. Moreover, new zooplankton could also be consumed by other fishes. Whether or not any increases in primary production will be transferred to zooplankton and on to covered species that may reside in the restored area or outside of it is largely unknown.

Based on a thorough and credible review of the scientific literature and extensive experience in the ecosystem, Mount et al. (2013) question whether the tidal marsh and floodplain restorations will deliver the food subsidies anticipated to Delta and longfin smelt. Their concerns seem justified. Increase in habitat area is not necessarily a metric for increases in habitat quality or functionality. Although the Adaptive Management Team is tasked with assessing the effectiveness of the restoration actions, there is no description of management actions that will be considered if the positive effects are not observed. Hence we are not able to determine if those actions could possibly compensate for the negative impacts identified.

POINT 2: Impacts of Flow Operations

The main impacts of new flow operations (CM 1) on fishes are 1) to allow flexibility to shift entrainment from the South Delta intakes to the new North Delta intakes and 2) to change flow rates and other associated conditions (e.g. water temperature and turbidity) downstream from the North intakes.

Entrainment

It is suggested that overall entrainment of fishes may be reduced by re-routing flows into the North or South intakes on the basis of fish distributions in the area as well as the use of improved intake structures at the North intakes (new screening processes and state-of-the-art positive barrier fish screens). However, one credible analysis of the modeled flow regimes (Mount et al. 2013) points out that, although significant uncertainties are incorporated into the CALSIM modeling, they are not given adequate consideration when statements about effects are made. In addition, both Mount et al. (2013) and a credible review by MBK Engineers (presentation at January 2014 ISB meeting) question whether the system can be operated as simulated in the CALSIM modeling and hence whether the predicted reductions in entrainment will actually occur. Therefore, estimates of entrainment should be bracketed based on model uncertainties.

Flow rates

The impact of altered outflow cannot be adequately assessed with the information given because the operational flows are not yet determined for Alternative 4. Some of the possible flow regimes have negative impacts. It has been established that the abundances of many of the covered species show a correlation with flow rates. Uncertainties about the level of spring and fall outflow will be addressed with two decision trees, one for fall and one for spring. It is argued that the decision-tree process will run for about 10 years and inform the initial operations of CM 1. Targeted studies will address this uncertainty before the new facilities are operational, but there is no description of these studies or a clear designation of how optimal flow rates can be balanced for different species. The decision-tree process will focus on longfin smelt and Delta smelt with consideration of salmon and sturgeon but no apparent consideration of other species. It is not clear what would be done if 'optimal' flows differ across these species. Moreover, other species abundances such as young-of-the-year striped bass also correlate with flows, and there is no consideration of potential changes in abundances of these young predators. Overall, it is stated that a science plan and data collection program will be developed and implemented but the design of that program is not stated, the amount and source of funding not identified, and the experiments to be done not determined. If the success of the studies is dependent on having years with a range of flow conditions, then success is uncertain at best. It is impossible to determine if the proposed research program will be adequate to address either the uncertainties that have been identified or the hypothesized causal mechanisms (turbidity, suspended solids, temperatures, salinity) that might lead to more informed flow operations.

POINT 3: Species Differences and Interactions

Overall, there was little consideration of interactions and synergies among species. Also, potential impacts on other ecologically important species in the ecosystem have been ignored or inadequately presented.

Species aggregation and inclusiveness

Because species were assessed individually in the evaluation of the effects of water operations, significant differences in effects among species were identified. In contrast to the detailed individual species discussions, the 9 non-covered species were lumped and considered as a group in Chapter 11 because the effects of most conservation measures 'on non-covered fish and aquatic species would be similar for all non-covered fish species included in Chapter 11". First, no reason is given as to why the 9 non-covered species are included and others excluded apart from being "identified by state or federal agencies as special status or of particular ecological, recreational, or commercial importance." (Page 11-1, lines 29-30). Clearly, one could argue that there are other species that have major ecological impacts in the Delta (e.g. two invasive clams) or that might be abundant and have competitive interactions with covered species (perhaps the centrarchids). Also, if habitat restorations become fully functional and provide predator refuge, feeding areas, or sources of food for covered species, the restorations must have impacts on many (perhaps hundreds) other species including the listed non-covered species. Some of these other species, such as nonnative predators and invasive clams, may also benefit from these expanded habitats. Benefits for the other species may dampen any benefits of the habitat restoration for covered species.

Second, the 9 non-covered fish and invertebrates have a huge range of ecological tolerances and requirements, life histories and behaviors. It seems unlikely that effects would be similar across all of these species. The treatments of covered species in the EIR-EIS revealed very significant ecological differences among species and even life stages. At best, this approach seems overly simplistic because we expect that individual species will have different responses to the proposed actions. At worst, this sort of lumping could lead to wrong conclusions because both predators (e.g. striped bass) and their prey (e.g. shad, California bay shrimp) are combined. Some of the proposed actions, for example in flow conditions, might favor a particular covered species but may also favor a non-covered predator such as striped bass. Some further justification for this approach should be given particularly because some of the non-covered species have strong interactions (e.g. predation) with some covered species.

Likewise, lumping phytoplankton, zooplankton and predators may also enhance uncertainty because clams can alter phytoplankton species composition, fish feed selectively on different types and sizes of zooplankton, and predator species differ in prey choice, feeding behavior, and thermal/habitat requirements. Other important elements of the food web in these habitats such as emergent and submergent macrophytes and edaphoic microalgae, were ignored. Moreover, there are literally hundreds of species of macroinvertebrates as well as other fish species that are ignored in the EIR-EIS, although these species play an essential role in the ecological functioning of the Delta ecosystem. It is difficult to draw species-specific conclusions based on the grouping of some species and exclusions of important food web components. We do not suggest that multispecies biological models are required but we do suggest that some sort of balance and rationale be given for species lumping and exclusions so that uncertainties in conclusions can be better understood and underlying assumptions can be formally expressed.

Species Interactions

It is not clear how the interactions among species are considered in time and space? Much of the EIR-EIS was focused on a detailed discussion of how an individual conservation measure (or a component of a conservation measure such as construction) might impact a specific species or life stage of a particular species. For example, each of the 11 fish species is discussed separately and extensively. However, there was an absence of consideration of interactions and synergies among species. We know we can't really manage species by species, and what is beneficial for one may be adverse for another. This concept has not been adequately captured or addressed. As mentioned, this becomes particularly important in the discussions of habitat restoration, which is intended to provide new food resources in the restored area and to the Delta. There is no consideration of how suggested increases in zooplankton food supply will be distributed among the target species. There is likely to be competition for these limited resources among covered species or with other species not considered. Information about who uses those resources is critical but not fully considered in the assessment. Food-web models do not adequately consider predators or competitors of the covered species. It did not appear that any biological feedbacks (e.g. resource depletion) were used in the analyses.

POINT 4: Delta Connectivity

Overall, there was little consideration of interactions and synergies among different proposed CM actions or between different geographic regions within the Delta and beyond the Delta.

It is not clear how the cumulative effect of restoration in different parts of the Delta is addressed. Conservation measures are planned in many different locations throughout the Plan Area and it is suggested that negative impacts in one area can be offset by positive impacts in another area. This necessarily contains an implicit assumption that the entire Plan Area is functionally interconnected both physically and biologically. It assumes that CM impacts on a particular life stage of a species in one part of the Delta can be balanced by other CM impacts that may occur at other times, on other life stages, and in other locations. This has not been demonstrated.

Additional consideration is needed of how factors outside the Plan Area interact within the Plan Area. The EIR-EIS included some forcing factors (such as climate change, tides, reservoir and upstream flows) and to a certain extent the potential for new invasive species from outside the Plan Area. Yet there is little discussion of biological influences or migrations from outside the Plan Area. A good example is longfin smelt, which has a baywide ecosystem distribution. Changes in flows may be very important in migrations into the Plan Area and the role of these smelt in other parts of the Delta. While the connectivity of the Delta ecosystem was not addressed for longfin smelt and other species, we note that the life cycle model for salmon does acknowledge the fact that salmon spend different portions of their life in different regions of the Delta, Bay and Ocean systems, and are impacted by how long they spend in the Delta and the timing of migration through the Delta. This approach was not used for other species. Also, there has been little effort to translate biological changes in the Plan Area to downstream regions.

POINT 5: Qualitative Analyses

The impacts on fish are largely assessed based on qualitative analyses, including expert judgment. The relation of these analyses to the specific models presented in the Effects Analysis (Chapter 5 of the Draft BDCP) is not clear. The qualitative analyses seem to conclude that the negative impacts of construction and flow operations will be minimized through Adaptive Management of operations and that the conservation measures will be beneficial and largely make up for the negative impacts. This type of statement is invalid in a qualitative comparison because: 1) the relative degree of the negative and positive impacts is unknown, and 2) CM 1 and CM 2 -22 impacts may operate on different life stages of a species. Some life stages may be more critical than others (e.g. bottlenecks).

The assessments of effects of each part of each conservation measure on fish and aquatic resources are qualitative, with considerable uncertainty in the conclusions reached. The methods used to assess effects are drawn in part from DiGennaro et al. (2012). The relative importance of a BDCP attribute (or stressor) affecting each life stage of each of the covered species was assessed largely by expert judgment (on a scale of +4 to -4) during a workshop. Scores were based on importance (none = 0, very high = 4) and on the basis of the degree of change of that attribute caused by the BDCP. These analyses could have been strengthened by:

1. Conducting an independent assessment by a second group of scientists. Conclusions are only as good as the expert judgment and without replication, uncertainty is high.
2. Qualitative analyses should include and fully document assumptions. The analyses need to recognize that conclusions largely provide a mechanism for verbal description of potential effects and provide a hypothesis of effects rather than any predictive forecast.

Net effects and the degree of certainty are tabulated for each attribute (e.g. Figure 5.5.1-5 for Delta smelt and 5.5.3-4 for winter-run Chinook), but the final assessment of overall net effects on an individual species is a qualitative narrative description, which is essentially a verbal interpretation of the tabulated net effects. Attempts to qualitatively balance positive and negative impacts (i.e. positive benefits compensate for negative impacts) are not valid because the relative strengths of these impacts are unknown. The authors' need to fully recognize the uncertainties inherent in the EIR-EIS analysis rather than simply providing tables stating no net effect. Moreover, the net effects analysis is highly uncertain because the combined importance of all effects was a subjective analysis of the attribute scores. Another group of experts may reach a different conclusion.

POINT 6: Full Life cycle considerations

For the covered species, each CM is often evaluated for each life stage of the species. It is often claimed that negative impacts of one CM and usually on one life stage can be offset by another CM that may be acting on another life stage. This type of analysis assumes full biological functionality and connectivity across the region. Moreover, it assumes that all life stages are equally important. Consideration should have been given to what is currently restricting a species production and an acknowledgement that actions on that bottleneck are likely to have a higher impact than actions on other life stages. For example, if larval recruitment is a serious life-stage bottleneck, then it is not clear that any efforts to improve juvenile conditions will have population-level impacts. We recognize that it is difficult to make these kinds of assessments until after there is a better understanding of the complete life cycle and the operations of stressors. Yet this limitation or added uncertainty needs to be addressed, particularly when conclusions are being made about 'net effects'. The OBAN and IOS life-cycle models that focused exclusively on Chinook salmon do not do this and do not include most of the CMs.

POINT 7: Adaptive Management

Several very specific Biological Goals or targets are defined in the Draft BDCP. For each species-level Biological Goal there are a variety of CMs that could contribute to that goal. Adaptive management is a key part of the overall Draft BDCP Plan. However, given that a number of CMs apply to a number of species, there is not an explanation of how adaptive management will be used to target the CM that is causing any changes observed for individual species. Research will need to be carefully designed to understand the causal relationships. There is no description of (a) how individual targets or thresholds will be determined across time to trigger an action, (b) how much progress is needed to maintain a particular action, (c) how much change would need to be observed to effect a change in the CM, or (d) what would happen if results were mixed across species (i.e., some covered species received a positive benefit and others received a negative benefit).

POINT 8: Uncertainty

The Delta is a physically, chemically and biologically complex ecosystem. There has been extensive research, monitoring and modeling for the Delta area but much remains unknown, particularly with respect to causal mechanisms. The ecosystem has also undergone major changes in hydrology and water flow, habitat structure, and biological composition, including a reduction in a number of species and massive invasions by others (e.g., clams). Much of this complexity and changes has been captured in the various sections of the Draft BDCP as well as some of the individual species descriptions in Appendices to Chapter 11. In this context, the EIR-EIS analyses are designed to predict the nature of the changes that might occur over the next 5 decades due to construction and operations of a massive new water conveyance system in the Delta and a series of efforts to restore habitats and institute a number of other Conservation Measures. All of this is done under major known or estimated (climate change, population increases) but also unknown (new invasive species or discovered causalities) changing environmental conditions. This is a daunting challenge.

Ultimately, the question is whether and what sort of effect the combined CMs will have on key covered species and on the ecosystem as a whole. To a large degree this remains uncertain and 'conclusions' of net effects analyses could be better termed 'hypotheses'. There are uncertainties in causality, the analyses performed, the future unknowns and changes or responses of other species and ecosystem components that are not considered, any or all of which could have indirect and unintended consequences.

We recommend that this uncertainty and the many underlying assumptions be dealt with upfront, forcefully and directly. There is uncertainty throughout all of these discussions. Quantitative estimates of uncertainty are rare. Moreover, the handling of uncertainty seems inconsistent throughout. The uncertainty of the level of understanding of the factors limiting species production, model validity and overall conclusions reached are more clearly acknowledged in the Draft BDCP than in the EIR-EIS. Sometimes the uncertainty in the data or models is used to outright eliminate the application of certain models (e.g., fish life cycle models). Other times the uncertainty in the output is stated as the conclusion (i.e., no conclusion can be drawn). Sometimes, the uncertainty is mentioned and yet other times the uncertainty is not mentioned at all. In general, the latter becomes more common as one moves from the Draft BDCP Plan to the EIR-EIS details to the Summary parts of the chapter. Often the rollup summaries are not reflective of the uncertainty of the issues expressed in the body of the report. Rollup of conclusions tend to downplay uncertainties. A typical example of this is on page 11-18 "The effects of the restored habitat conditions (CM 2…CM 4…CM 5…CM 6…and CM 7..) would be beneficial for all covered species because there would be an increase in the amount of habitat as well as food production in, and export from, the restored areas". The certainty of this conclusion is not reflective of the uncertainty of the analyses.

Table 11-1A-SUM2 is another example of the problem mentioned above. Data clearly show a relationship of outflow to splittail abundance and any reduction in that flow might have a negative impact. Although the EIR-EIS claims a positive impact from the Yolo Bypass, the table itself shows the net effects of flows on splittail are not adverse, less than significant or even beneficial. These types of conclusions without precautionary notes about uncertainties or assumptions can be misleading.

In addition, there are clearly many assumptions that are necessarily part of any such analyses. We suggest that the fundamental assumptions be succinctly stated up front in each section. Statements of assumptions allows a more logical evaluation of conclusions, and would provide a more balanced and understandable presentation of the methodology used.

POINT 9: Cumulative Effects

The analyses are targeted towards assessing impacts over a 50-year period Yet, many of the effects on individual fish are evaluated at points in time, normally only for a year or for a particular life stage. It is possible that a low impact (positive or negative) of a few percent during a year can have a significant effect if accumulated (and compounded) over each year for 50 years, but it is not clear if this been incorporated into any of the biological models.

POINT 10: Additional General Questions/Points

- Temperature plays a key role in fish growth and reproduction and fish physiology and behavior is often very sensitive to small changes in temperature. Although temperature was considered in the sturgeon analyses it is not clear that it was fully considered in other species, particular for those where temperature might be near critical thresholds.

- Flows are considered important to many fish species yet the causal relationships of fish abundances with flows remains enigmatic. Will research and monitoring (e.g. as part of the decision-tree analyses) include measures of other potential forcing factors such as water temperature, predation rates, suspended solids, salinity and food densities?

- How were (or will) thresholds or tipping points be considered in the analyses or adaptive management programs?

- There was very little discussion of the two invasive clam species which, according to the published literature, have had a huge impact on the ecological functioning of the Delta ecosystem (e.g. changes in chlorophyll levels, species compositions, Microcystis). Were they fully considered in the analyses of habitat restoration and potential new food sources?

- Wherever possible modeling should show 'bracketed results' or ranges of uncertainty.

- Propagation of errors in physical/hydrodynamic/hydrological models will be compounded when then applied to biological models as forcing functions.

References

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Chapter 12: Terrestrial Biological Resources

Overall assessment

Chapter 12 uses a logical approach, a wealth of detail, and thoughtful analysis in evaluating potential impacts to terrestrial habitats and organisms. Unlike the rest of the EIR/EIS, it makes many of its findings accessible in a comprehensive lead-off summary. Like the rest of the EIR/EIS, however, understanding and evaluating the material in Chapter 12 requires frequent referencing to other chapters, and to multiple places in the BDCP Plan.

Our main concerns:

1. *Losses and gains*—To simplify estimates of losses and gains in habitat, the chapter equates a species' habitat with one or more natural communities. This simplification weakens the link between habitat value and habitat losses and gains and contributes to uncertainty in the calculations.
2. *Restoration timetables*—The chapter sets optimistic expectations about the time required to replace a mature habitat of slow-growing terrestrial species.
3. *Restoration effectiveness*—There is an implicit assumption that the projected habitat gains from restoration and protection needed to offset habitat losses associated with BDCP actions will be fully realized. Experience suggests that this is rarely the case.
4. *Performance measures*—The chapter lacks, even as summaries derived from the Plan, detailed metrics of desired ecological results of the various conservation measures.
5. *Adaptive management*—Adaptive management is frequently mentioned as the solution if things don't work out as planned, yet few details are provided (these are in the BDCP Plan) and lessons from terrestrial habitat restorations that were managed adaptively are scarce or absent.
6. *Monitoring needs*—Implementing the Plan will require extensive monitoring landward of the traditional coverage through the Interagency Ecological Program. The demands for monitoring may be underestimated (and therefore underfunded).
7. *Linkages*—In contrast with the Plan's emphasis on linking conservation measures in space and time, Chapter 12 mostly treats each species and each action independently of other species and actions.
8. *Contingency plans*—It is unlikely that all the actions and measures in BDCP will play out as planned. Beyond calling on adaptive management, there is little indication of any back-up plans if habitat restoration falls short because of funding, unwilling sellers, climate change, or other factors.

Chapter aims and scope

Chapter 12 of the EIR/EIS, which addresses the potential impacts of BDCP conservation measures on terrestrial biological resources, begins with an informative summary. Effects on natural communities, covered plant and animal species, and other species of concern are considered; most of the attention is on species. The general approach to gauging impacts, compensating actions, and mitigation for species is to (1) use available information to construct a habitat suitability (HSI) model for the species; (2) use the model in combination with GIS to determine where available habitat occurs, weighted by habitat value; (3) overlay the areas that will be affected by various actions under the conservation measures to determine the loss of available habitat; (4) compare with the amounts (and occasionally locations) of habitat to be restored or protected to determine whether they compensate for losses; (5) supplement with Avoidance and Minimization Measures (AMMs) and/or other specific management actions to enhance the value of restored or protected areas or reduce impacts; and (6) where necessary, implement additional Mitigation Measures to ensure sufficient habitat availability.

This is a logical approach. The analyses of impacts on natural communities and species from the conservation measures associated with alternatives are comprehensive and detailed. In most cases, the proposed habitat restoration will more than compensate for the losses associated with construction and operation. Where it falls short, additional actions are proposed. For example, loss of acres of vernal pool complex is estimated to be greater than replacement through protection and restoration in the near term. The difference is anticipated to be addressed through a variety of restrictions on activities or AMMs: "With these AMMs in place, Alternative 4 would not adversely affect vernal pool complex natural community in the near-term" (p. 12-2048; unless otherwise noted, all page references are to the EIR/EIS documents).

Numerous AMMs and Mitigation Measures are proposed to supplement the habitat protection and restoration measures. In many cases, these involve conducting surveys to obtain additional information on distribution in the study area (e.g., Mitigation Measure BIO-55, p. 12-2161), target and protect sensitive areas (e.g., Mitigation Measure BIO-75, p. 12-2241), or evaluate the potential effectiveness of proposed conservation actions. For example, the loss of managed wetland habitat for shorebirds and waterfowl in Suisun Marsh would be mitigated by the protection or restoration of 5,000 acres of seasonal wetlands, assuming that "1) existing managed seasonal wetlands on average in Suisun Marsh provide low biomass and low-quality food to wintering waterfowl and 2) protected seasonal wetlands can be managed to produce high biomass and high food quality. However, the food biomass and productivity in Suisun Marsh would need to be quantified in order to determine if the 5,000 acres was sufficient to avoid an adverse effect on wintering waterfowl in the Suisun Marsh, or if additional mitigation would be needed. Mitigation Measure BIO-179a, Conduct Food Studies and Monitoring for Wintering Waterfowl in Suisun Marsh, would be available to address this adverse effect" (p. 12-2561). Many of the AMMs or Mitigation Measures are quite detailed, evidencing sensitivity to the specific ecological requirements of the species.

Quality of analysis

The amount of detail provided in Chapter 12 and its appendices is impressive. There are numerous instances in which the treatment of potential impacts and the measures proposed to counteract them are thoughtful and comprehensive. In some cases, the analysis delves into great detail about what might seem to be potentially minor effects. Concerns are raised, for example, about possible alterations of the photoperiod of sandhill cranes due to lighting at construction sites or on new roadways (p. 12-2210). In other situations, however, little supporting detail is provided or the reader is referred to material in other chapters or in the BDCP Plan.

Chapter conclusions

The overall conclusion of the chapter is that the only non-mitigateable impacts of BDCP would potentially affect bank swallows, through disturbance and/or loss of breeding habitat, and giant garter snakes, through disruption of movement corridors by canal construction (for alternatives 1B, 2B, and 6B) (see pp. 12-3229 – 12-3243). Additionally, although sufficient conservation acreage would be provided by the conservation measures to offset near-term effects of Alternatives 1A, 2A, 3, 4, 5, 6A, 7, 8, and 9, “insufficient cultivated land would be protected (and enhanced) under Alternatives 1B, 1C, 2B, 2C, 6B and 6C to offset loss of habitat for species that use cultivated lands for foraging. Alkali seasonal wetland complex and vernal pool crustacean habitat (alkali seasonal wetland complex and/or vernal pool complex) would need to be restored and protected in addition to what is currently in the Plan under Alternatives 1C, 2C and 6C, as described in Mitigation Measures Bio-18, Bio-27, and Bio-32” (p. 12D-39).

Although an EIR is required to identify the “unavoidable significant environmental impacts” of a project pursuant to Section 15126.2(b) of the State CEQA Guidelines, the non-mitigateable potential impacts of BDCP on bank swallows and giant garter snakes (or, indeed, on any terrestrial biological resources) are not included in the broader listing of impacts and mitigation measures in Chapter 31 (Table 31-1).

Areas of concern

Finding what one needs to know to understand or evaluate a particular statement or conclusion in the EIR/EIS often involves a considerable amount of searching through thousands of pages, as well as delving into referenced (and non-referenced) material in the BDCP Plan itself. Based on our attempts to do this, we have several concerns with the treatment of terrestrial biological resources.

<u>Determinations of “habitat” and “habitat value,” while often detailed, do not acknowledge several sources of uncertainty that may compromise assessments of habitat losses and restoration gains</u>

The emphasis of the analyses is on habitat. Potential impacts of BDCP actions are in most cases evaluated in terms of loss (or, in some instances, diminishment in value) of habitat, and compensation for losses is through protection, restoration, and/or management of the same or similar habitat. Additional actions are proposed if the amount of “replacement” habitat created does not balance the habitat loss.

“Habitat” for natural communities is determined by classifying communities into several types, which are then mapped. For species, “habitat” is defined through the development of habitat suitability (HSI) models. The results are then used to calculate potentially available habitat and what habitat might be lost or gained as a result of BDCP actions. The details of the HSI models are not in the EIR/EIS but are provided in Chapter 2 of the BDCP Plan. These appear to be carefully done, making good use of available literature and unpublished information; Appendix 2A of the Plan discusses the assumptions and underlying rationales for each of the HSI models. The EIR/EIS correctly notes that the models “do not necessarily indicate with certainty that covered species would not occur in all areas not identified as habitat; but instead indicate that these areas have a much lower probability of species occurrence compared with areas identified as suitable habitat. Habitat suitability models are a tool used to estimate impacts to obtain a maximum allowable habitat loss. On-the-ground surveys, performed by professional biologists, will determine impacts during implementation" (p. 2A-4). In other words, lots of monitoring!

The specifications of habitat for a species derived from the HSI models are often quite detailed. In a listing of principles to guide the conservation strategy for aquatic species (BDCP p. 3.2-5 to 3.2-7), the BDCP Plan correctly observed that "habitat should be defined from the perspective of a given species. Habitat is a species-based concept reflecting the physiological and life-history requirements of species. Habitat is not synonymous with vegetation type, land (water) cover type, or land (water) use type." Nonetheless, in calculating the habitat loss/gain functions that are the foundation of assessments of BDCP impacts, habitat has been generalized to correspond with one (or more) of the natural community types. While this generalization was probably necessary to permit the analysis of habitat losses and gains using GIS analysis, much of the useful and important detail in the HSI models has been lost (although it reappears now and then in the AMMs and Mitigation Measures for individual species). Thus, there is often an unspecified (but potentially large) uncertainty associated with the habitat loss/gain calculations.

This uncertainty may be exacerbated by uncertainties in the distributional data that are used in concert with the habitat information to define where a species occurs, and therefore its vulnerability to the construction and restoration actions under different alternatives. The distributional data (provided in a series of maps for the species considered) require several assumptions, most importantly that (1) the distribution has been adequately surveyed; and (2) the distribution is stable. The distributional data come from a variety of sources over an unspecified time period (although the data sources may be given in some undisclosed location in the EIR/EIS or Plan). They are based largely on records in the California Natural Diversity Data Base (CNDDB). Because this is a presence-only database, confirmed absences (0 values) are ignored and can only be inferred, compromising its value. The database is also incomplete. For example, CNDDB contains only a partial download of records of bird distributions in the California Avian Data Center (CADC). This source of uncertainty is not acknowledged, nor are its potential consequences explored.

Uncertainties in the distributional information may also affect the assessment of habitat "value." There is frequent mention of the expectation that restored or protected habitat will be of greater value than the habitat that is lost to BDCP activities, so the amount of replacement acreage may actually underestimate the "functional" acreage available to a species. "Value" is determined based on recorded distribution and abundance in different vegetation cover types and/or species' ecology. For example, for giant garter snake "the modeled upland habitat is ranked as high-, moderate-, or low-value based on giant garter snake associations between vegetation and cover types (U.S. Fish and Wildlife Service 2012) and historical and recent occurrence records (Appendix 12C, 2009 to 2011 Bay Delta Conservation Plan EIR/EIS Environmental Data Report), and presence of features necessary to fulfill the species' life cycle requirements" (p. 12-2131). Although this approach is reasonable, it rests on the assumptions that (1) current distribution reflects optimal habitat selection; (2) the distributions have been adequately surveyed and are not undergoing rapid changes; and (3) the restored habitat will actually be better than the habitat lost. There is a clear intent to manage for improved habitat, considering such factors as spatial heterogeneity and connectivity; to the extent that this is realized, the last assumption is probably valid, but it does rest on an accurate understanding of the habitat requirements of the species.

Expectations for habitat restoration and protection are unreasonably optimistic

Assessing the potential impacts of BDCP actions begins by determining how much (acreage) of a given habitat is lost or converted to something different—i.e., the "footprint" of the action. The loss is then offset by restoring or protecting an equivalent or greater amount (acreage) of the lost habitat. The calculations in the EIR/EIS are therefore made in acreages. There is an implicit assumption that an acre lost can be replaced by an acre gained. The EIR/EIS discusses two approaches for dealing with cases in which the gains don't balance the losses. First, it is frequently proposed that the replacement habitat is of greater value, as discussed above. Second, the calculation of "mitigation ratios" (how many acres should be restored or protected to replace an acre lost) considers factors such as importance (value) of habitat to a species, species rarity, threat levels, and uncertainty about the effectiveness of restoration (see p. 12D-3). Although this seems to be a reasonable approach to gauging mitigation efforts, it would be good to know how uncertainties of restoration effectiveness were assessed.

Habitat restoration is a complex and time-consuming process, The EIR/EIS recognizes this and devotes considerable attention to the timing of restoration efforts. In particular, plans are outlined to ensure that restoration is in phase with habitat loss, so that gaps in habitat availability to a species are minimized. Some restoration is scheduled to begin shortly after permitting of BDCP, whereas conveyance operations will not begin for at least a decade (although construction of the intake facilities will begin soon after permitting). While this difference in phasing may help to ameliorate impacts of habitat loss for aquatic species, it will be less effective for terrestrial species and communities. For slow-growing flora, such as valley/foothill riparian woody vegetation (p. 12-2015), or species that rely on mature habitats, such as black rails that occupy well-developed tidal wetlands (p. 12-2165), or Swainson's hawks, white-tailed kites, Cooper's hawks, or ospreys, which require mature trees for nesting (p. 12-2255), there may be a temporal mismatch between the loss of mature habitat components and restoration. It may take decades to redeem the lost value. For the latter species, "this time lag between impacts and restoration of habitat function would be minimized through specific requirements of AMM18 Swainson's Hawk and White-Tailed Kite, including transplanting mature trees in the near-term time period" (p. 12-2255).

For something like a hawk, however, "habitat" depends on much more than having a suitable tree for a nest. One can't transplant an entire functioning mature riparian ecosystem. It is inevitable, therefore, that there will be a substantial gap between the loss of habitat for such species and the re-emergence of habitat that meets the full complement of a species' requirements. If this takes decades, population dynamics may be disrupted and local extirpation may follow. The analysis for salt marsh harvest mouse, for example, warns that up to 20% of the species' habitat in the Plan Area may be affected, diminishing the population and reducing genetic diversity, "thereby putting the local population at risk of local extirpation due to random environmental fluctuations or catastrophic events. This effect is expected to be greatest if large amounts of habitat are removed at one time in Suisun Marsh and are not effectively restored for many years, and if there are no adjacent lands with salt marsh harvest mouse populations to recolonize restored areas" (p. 12-2485). The expectations for restoration of mature habitats, even if supplemented by Mitigation Measures and AMMs, strike us as unrealistically optimistic.

For many natural communities and species, the effects of CM1 cies are to be mitigated by the creation of restored habitat of equal or greater value in Restoration Opportunity Areas. For natural grasslands, for example, the analysis of long-term effects for NEPA projects a loss of 2,947 acres by the end of the Plan timeframe. The 2,000 acres of restoration associated with CM8 and the restoration of temporarily affected grassland required by AMM10 (431 acres for Alternative 4) would not totally replace the grassland acres lost. There would be a permanent loss of 516 acres of grassland in the Plan Area. However, "the combination of restoration, protection and enhancement of grassland associated with Alternative 4 would improve the habitat value of this community in the study area; there would not be an adverse effect on the grassland natural community (p. 12-2070).

In this example, as elsewhere in this chapter, one has the impression that there is full confidence that the projected gains in habitat will in fact materialize. There may be considerable certainty about the losses, particularly those associated with construction activities, but there is far greater uncertainty about the mitigation. Will the restoration actually be done? Where will it be located ("somewhere in a Restoration Opportunity Area" leaves a lot of uncertainty)? Will funding be adequate? Will appropriate areas be obtained from willing sellers? Will the species and communities come? Will climate change and sea-level rise erase the restoration gains? These questions are not adequately addressed, and the consequences of failing to reach the restoration, protection, or mitigation goals are not considered (at least in this chapter). Simply referring to adaptive management as a way to deal with such uncertainties is not sufficient.

One aspect of uncertainty that *is* addressed in this chapter (in Appendix 12D) is ecological feasibility: are suitable conditions present within specified conservation zones to implement the appropriate near-term conservation measures? Although the assessment explicitly excludes consideration of socio-economic or engineering aspects of feasibility, there is a comprehensive analysis of the presence of lands supporting required unprotected natural community acreage in specified conservation zones to support natural community protection, and of the presence of lands that meet suitability criteria, such as species range, soil type, land use, natural community, and land elevation to support restoration of natural communities or species habitat (p. 12D-2). Appendix 12D is where one can find details about what goes into the determination of mitigation ratios, what principles will be used to guide the selection of areas for protection as part of the BDCP reserve system, and what criteria might be used to judge the suitability of restoration sites. Although the treatment of these factors is generally excellent, the approach fails to consider how the spatial and temporal sequencing of restoration projects can influence their effectiveness in contributing to BDCP goals. Which sites are selected for restoration of habitats at one time may depend on which sites are already being restored and where they are. These sequencing effects may be particularly important for projects associated with waterways, where flows connect places. Such considerations are mentioned in the chapter in connection with the intent to include connectivity among habitats as a factor in planning, but the implications are deeper than that.

Climate change and sea-level rise can create additional uncertainty in habitat restoration efforts. We consider some implications for tidal marsh restoration in greater detail in Box 1.

Box 1. The ability of tidal wetlands to keep their heads above water as sea level rise

Impacts assessed

The anticipated outcomes of tidal marsh restoration under the BDCP depend largely on whether new tidal marshes will survive the rise in sea level projected for the 21st century. Several of the BDCP documents under review consider this question:

- BDCP Plan Appendix 3B, "BDCP Tidal Habitat Evolution Assessment," presents results of modeling that simulates the fate of marshes at Suisun Bay and in the Delta during the next 50 years.
- BDCP Plan Appendix 5E, "Habitat Restoration," refers to this modeling and, in three main places, provides background discussion (p. 5.E-37, EA.4-18 in section E.A.4, and 5E.B-9). Included is a proposed strategy of getting new marshes established soon, before sea-level rise accelerates to the rates forecast for late in the 21st century (p. 5E.B-7).
- BDCP Plan Appendix 5.A.1, "Climate Change Implications for Natural Communities and Terrestrial Species," refers briefly to marsh accretion.
- EIR/EIS Chapter 12 repeatedly mentions accretion without analyzing it to the level of detail in Appendices 3B and 5E.

The background discussions include brief reviews of how marsh plants as well as suspended sediment can influence vertical accretion in tidal marshes. The references cited include recent journal articles about marsh accretion at the San Francisco Bay estuary (Callaway et al., 2011; Stralberg et al., 2011) and the best available measurements of below-ground productivity by *Schoenoplectus acutus*, the main bulrush among Delta tules (Miller and Fujii, 2010).

Issues

<u>Doubtful projections</u>

The accretion estimates in Appendix 3B rely on simplified modeling for Suisun Marsh and on an optimistic assumption for the Delta.

For accretion modeling at Suisun Marsh, Appendix 3B relies on a simplified method used by Orr et al. (2003). In this method, above- and below-ground contributions by marsh plants are assumed to raise the marsh surface by 1 mm per year, and the role of inorganic sediment is estimated from suspended-sediment concentrations. More recent models include specific factors for injected roots and rhizomes and for soil decomposition (Mudd et al., 2009; Kirwan et al., 2010; Kirwan et al., 2011; Fagherazzi et al., 2012; Takekawa et al., 2013). Such models do not appear to have been used in the BDCP projections.

For the Delta, Appendix 3B assumes that marsh accretion keeps pace with sea-level rise (p. 7). The report goes on to qualify this assumption: "The ability of marshes to keep pace with higher rates of sea level rise is not yet well understood" (p. 8).

Outdated references

The related reference lists cite no post-2011 reports about tidal-marsh accretion excepting, in Appendix 5B, a piece by a science journalist (Kintisch, 2013). A more timely assessment might have considered the accretion modeling cited above and its implications for 21st-century tidal marshes. Also directly relevant are recently published observations of modern accretion rates in San Francisco Bay estuary marshes (Callaway et al., 2012; Thorne et al., 2013) and prior accretion rates in the Delta (Drexler et al., 2009; Drexler, 2011). Updated background on roles of inorganic sedimentation could cite recent reports on horizontal accretion (Gunnell et al., 2013) and coastal sediment starvation (Fagherazzi et al., 2013).

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Performance measures, adaptive management, and contingency planning are treated inconsistently or not at all

In view of the uncertainties that accompany many of the actions and responses that are part of BDCP, it is important to be asking continuously how well the goals and objectives are being met. Performance measures are essential. For BDCP as a whole, performance is gauged in terms of progress toward meeting the biological goals and objectives that are part of the overall conservation strategy. All mentions of performance measures in the EIR/EIS simply refer to these goals and objectives. In some instances the accounts are quite detailed. For example, in the account for loggerhead shrike we are told: “Under CM11 Natural Communities Enhancement and Management, insect prey populations would be increased on protected lands, enhancing the foraging value of these natural communities (Objectives ASWNC2.4, VPNC2.5, and GNC2.4). Cultivated lands that provide habitat for covered and other native wildlife species would provide approximately 15,400 acres of potential high-value habitat for loggerhead shrike (Objective CLNC1.1). In addition, there is a commitment in the plan (Objective CLNC1.3) to maintain and protect small patches of trees and shrubs within cultivated lands that would maintain foraging perches and nesting habitat for the species. The establishment of 20- to 30-foot-wide hedgerows along field borders and roadsides within protected cultivated lands would also provide high-value nesting habitat for loggerhead shrike (Objective SH2.2). These Plan objectives represent performance standards for considering the effectiveness of conservation actions.” (p. 12-2428).

Most species accounts in the EIR/EIS, however, make no mention of objectives or performance measures. Instead, the biological goals and objectives are presented in Chapter 3 of the BDCP Plan. The biological goals and objectives are either performance-based (was an action undertaken) ot results-based (did it have the anticipated effects). For terrestrial resources, the objectives are mostly performance-based (which are easier to measure); results-based objectives are more difficult to measure, but they are ultimately what BDCP is all about. Chapter 3 of the Plan includes lengthy tables and text listing the biological goals and objectives and describing the underlying rationale for each; the specific monitoring efforts for compliance effectiveness *and* the specific metrics that will be used to judge performance; the major sources of uncertainty associated with CM1; and research actions necessary to reduce the uncertainties (performance can also be judged on the basis of success in reducing the listed areas of uncertainty). These are all important details. Even though these details are included in the BDCP Plan, their absence from the EIR/EIS, even in a summary form, diminishes its comprehensibility and scientific value substantially.

In a well-planned undertaking such as BDCP, performance measures should provide a frequent assessment of whether actions are having the desired effects. This is the domain of adaptive management. Adaptive management is *the* key to the success of BDCP over the project duration. The adaptive management approach and administrative organization are described in detail in the BDCP Plan (Chapter 3, Section 3.6, and Chapter 7). Yet, adaptive management receives an even more cursory treatment in the EIR/EIS than do performance measures. Adaptive management is mentioned frequently in the EIR/EIS with no details about how it might be implemented; rather, it is often presented as a panacea for all problems. Even so, there are numerous instances in which the elements of adaptive management are elaborated without the term being mentioned. For example, on p. 12-2081 the amount of habitat restoration is adjusted depending on the rate at which habitat is lost (primarily through restoration of tidal wetland) and the timing of activities. Or on p. 12-2233 it is proposed that if breeding occurrences of least

Bell's vireo and yellow warbler are documented in the survey area, consideration will be given to control of nest parasites and predators to foster population persistence. These are good examples of adaptive management based on field monitoring, although they are not presented as such. We consider adaptive management in detail elsewhere in this review.

Monitoring and adaptive management are proposed to evaluate whether things are proceeding as planned. What if things don't go as planned? The history of ecological restoration tells one that restoration projects rarely result in exactly what is desired, when it is expected. Implementation of many of the AMMs anticipates that various activities (e.g., construction, roads) will be able to be redirected or retimed to avoid or minimize potential impacts. There will inevitably be situations, however, in which the adjustments are not possible or incur too great a cost. What then? Given the complexity and the high stakes of many of the actions to be undertaken in BDCP, it would seem prudent to have contingency plans at least generally outlined *before* discovering that things aren't working. There is little mention of contingency plans in the event that a given action does not produce the desired results.

<u>The effects of linkages and tradeoffs among species or actions are not adequately recognized</u>

The Delta is a complex, interconnected place, in which what happens in one place at one time has cascading effects elsewhere at a later time. Correspondingly, the BDCP undertaking is complex, with many things going on at different places and times, all linked together in different ways. The Plan and the EIR/EIS must acknowledge and consider these interconnections.

Both the Plan and the EIR/EIS do recognize the need to connect places undergoing restoration or targeted for protection. Establishing connectivity among patches of habitat to facilitate movement of individuals is considered as part of the planning for many species. Landscape ecologists distinguish between "structural" connectivity (i.e., what is seen on a map or a GIS image) and "functional" connectivity (i.e., how organisms actually use connections). The approach taken by BDCP understandably relies on the former, in particular the patterns developed in the California Essential Connectivity Project. Without knowing the specific locations for habitat restoration within the broadly defined Restoration Opportunity Areas, however, it is difficult to evaluate how structural connectivity will be established in practice (although the intent is clearly there). Elements of functional connectivity might be incorporated into the planning by relying on the details of species' ecologies contained in the HSI models.

Connections among actions may be even more important than connections among places. Actions taken to benefit one species may benefit or harm other species. Thus, "Riparian restoration in those more interior portions of Old and Middle Rivers that would be managed for riparian brush rabbit habitat have potential to benefit resident western pond turtles because riparian-adjacent grassland is an important habitat characteristic for the rabbit" (p. 12-2154). However, "the restoration programs will increase primarily wetland and riparian natural communities by converting agricultural land or managed wetland. The special-status and common plants and wildlife that rely on wetland and riparian habitats for some stage of their life will benefit from these changes over time. Other species that rely on agricultural land and managed wetland, but do not benefit from wetland and riparian expansion, may decline in the study area" (p. 12-3226). In other words, some (perhaps many) actions will entail tradeoffs.

The importance of considering linkages among places and among actions is clearly stated in the conservation strategy of the BDCP Plan: "substantial benefits of the conservation strategy are derived from understanding interconnections between conservation measures across program elements, across the wide geography of the Delta, and across time. In short, the conservation strategy is intended to be greater than the sum of its parts" (BDCP p. 3.2-3; see also BDCP p. 3.2-5 to 3.2-7). Aside from brief mentions (e.g., p. 31-28 and following), however, the EIR/EIS fails to follow through on the intent of the conservation strategy, instead usually considering each species and each action independently of other species and actions (although several species are grouped together for discussion on the basis of their ecological similarities).

Chapter 15 Recreation

1.Scopes of Impact Covered

Chapter 15 details the physical environment, recreation facilities, and both recreation activities and opportunities of the Delta Plan Area. There are numerous parks, extensive public lands, and private areas with many interconnected waterways that offer diverse recreation opportunities ranging from boating and fishing (the principal recreational activities) to camping, bird watching, sightseeing (e.g. wineries), hunting, wildlife viewing, trail hiking and walking to picnicking. The EIS/EIR focused primarily on; 1) how the actual construction and maintenance of new structures will impact recreational use at that location or in the immediate vicinity and 2) how the operations of the water flow system (CM1) in each of the alternatives might affect recreational opportunities. Most of the latter are focused on the frequency that reservoir levels will exceed the threshold set for recreational impairment.

a) Are the impacts addressed complete (including links to other chapters)?

Readers are referred to other chapters on Socioeconomics (Chapter 16), Aesthetics and Visual Resources (any changes in resources might affect their draw for recreation, Chapter 17), Fish and Aquatic Resources (changes in abundance or mix of creational fishes or even the perception of changes might affect recreational fishing, Chapter 11), Public Services and Utilities (Chapter 20), Transportation (e.g. traffic patterns, Chapter 19), Environmental Justice (differential use of recreation facilities, Chapter 28) and Noise (Chapter 23) to review the assessment of how the BDCP will impact these resources. Unfortunately those results were not reconnected or cross-referenced to their impact on recreation including tourism.

An aspect of the impacts not mentioned in this chapter that will be a consequence of all alternatives is covered in detail in Chapter 25, *Public Health* This is the increases in potential vectors of human and disease, and especially of the biting nuisance caused by mosquitoes. For example, as stated elsewhere in the EIR, “Construction of the water conveyance facilities and water supply operations under all action alternatives would result in an increase in sedimentation basins and solids lagoons. These new features could result in an increase in standing water, thereby potentially increasing vector breeding locations and vector-borne diseases in the study area” p. 25-34, lines 18-21). At individual construction sites near recreation sites or areas and in-river, construction would be primarily limited to June through October each year. This, of course, is the period of peak mosquito breeding and biting activity in the Delta. Moreover, the economic cost of nuisance mosquitoes is not discussed in either this chapter or in Chapter 25 of the EIR. Increases in mosquito populations will affect virtually all recreational activities in the Delta (e.g. fishing, camping, wildlife viewing, sightseeing) resulting in loss of recreational opportunities and increased human discomfort. This chapter of the EIR should include this topic as a direct cost on recreational activities in the Delta.

b) Are the impacts emphasized with respect to their importance?

More attention needs to be paid to the other conservation measure because a number of these have the potential of resulting in either positive or negative impacts on recreation. For example, CM 17 reduction of illegal harvest would provide more fish for those who take fish legally. CM20 might help reduce invaders which would help the ecosystem overall but might come at a cost to boaters who would have to have their boats inspected. CM13 and CM 15 are both intended to reduce the local densities of ‘nonnative predators’ on selected species. These predators may likely include (although not specifically identified) striped bass and largemouth bass which support a lot of the recreational fishing. How will this predator reduction effort affect fishing per se or the fishers draw to this area to fish?

2. Quality of Analysis

a) Is the literature from which the analysis builds appropriate?

The literature used is appropriate.

b) Are the formal models and/or broad patterns of reasoning relied upon the "best available"?

Formal models are generally not applied. Therefore, the questions below do not apply.

c) Are the inputs (or other basic facts) to the models/reasoning the best available?

d) Where modeling judgments and interpretive reasoning are invoked, are they appropriate?

e) Are the results and their uncertainties interpreted in a "balanced" way with respect to the strengths and weaknesses of the alternatives under consideration?

3. Overall Assessment of whether and how this chapter helps inform BDCP

In general, the material in this chapter is useful and informative to BDCP. However, inclusion of information suggested above, and better linkages with other chapters would increase its applicability.

Chapter 22, Air Quality and Greenhouse Gases

I. Scope of Impacts

Chapter 22 addresses local and regional air quality impacts of criteria air pollutants and toxic air contaminants (TACs) emitted or generated during the construction and operation of BDCP alternatives. GHG emissions associated with the project are analyzed in relation to regulatory limits as well as control measures. BDCP could facilitate new growth and development in SWP and CVP Export Service Areas, and air quality associated impacts of such growth are addressed in §30. Climate change impacts on project alternatives are discussed in §29. They all are in the category of controversial community issues (ES§ 7).

The study area for air quality effects includes immediate surroundings of project activities, within 1000ft of construction and operations. For GHG, the area is much broader due to global nature of GHG forcing. Three (SVAB, SJVAB, SFBAAB) of the fifteen California air basins are identified as important for the study. Each of the air basins is described with regard to geography, climatology, air pollution and meteorology. Air pollutants are considered in the framework of EPA criteria pollutants (which are further classified in terms of regional and local pollutants) as well as TACs. Health impacts of pollutants are identified and assessed. The National Ambient Air Quality Standards (NAAQS), CAAQS and CCAA are outlined, and the attainment status of the three air basins in point are listed (Table 22-3). It appears that violations of NAAQS and CAAQS and prevalent in the three air basins with regard to ozone and PM, to the extent that they are classified as non-attainment. Increased emissions can be regarded as adverse, and BDCP proponents are expected to develop an Air Quality mitigation plan (AQMP) to ensure that regulations and recommended mitigation are incorporated into future conservation measures. The GHG emissions are discussed in relation to climate change, CEQA guidelines §15364.5, CEQA OPR Advisory, DWR climate action plan and California Global Warming Solutions Act (AB 32). TACs in California are primarily controlled through the Tanner Air Toxics Act (AB 1807) and Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588). Local laws may trump certain Federal and CEEQA regulations.

Air pollutants and GHGs are generated during the construction phase as well as operation of water conveyance facility [CM1]. In the former, the dominant emissions include those from mobile and stationary construction equipment exhaust, employee vehicle exhaust, dust from land clearing and earthmoving, electrical transmission, and concrete batching from onsite plants. As such, this EIR/EIS assumes a particular schedule and phasing of activities, which are imperative for emission modeling (Appendix 22A).

The potential air quality and GHG effects of [CM1] and habitat conservation measures [CM 2–22] have been analyzed, and their implications of [CM1] on sensitive receptors associated within residential and recreational land use are evaluated quantitatively at the project level (within 1000 feet of the operations). The effects of [CM 2–22] are evaluated qualitatively at the program level. It is argued that it may be sufficient to consider only the air quality and GHG impacts of [CM 2-11]. Cumulative analyses are also presented.

The three air basins cut across four air quality districts [YSAQMD, SMAQMD, BAAQMD, and SJVAPCD] that have different emission standards for criteria pollutants and TACs; *de minimis* threshold levels for each basin have been identified. Many of these districts are already either non-attainment areas or maintenance areas, so extra emissions can have significant impacts. The cases of construction and long term operations are analyzed separately for different (nine) alternatives and nineteen potential impacts (AQ 1-19) are identified and mitigation action are proposed. The analysis is fraught by the need to comply with or consideration of a myriad of federal, state and local environmental standards. CEQA standards are more stringent than NEPA, and both do not impose thresholds for GHG.

No action and action alternatives are considered in detail, using projections of future climate that includes changes in temperature, precipitation, humidity, hydrology, and sea level rise. Some or all air quality districts are affected by the alternatives. Given the uncertainty of pollution emissions in construction activities, the considerations are only qualitative for [CM 2-11]. In all, the emissions appear to contribute significantly to criteria pollutants during the construction phase but not in the operation phase. Mitigation actions are required, and proposed through a series of mechanisms such as fees and offset reduction programs.

II. Quality of Analysis

This EIR/EIS has been done thoroughly and carefully, considering myriad of sources and project alternatives. The results are physically plausible, more the construction activities the higher the air quality impacts, and they occur during the construction phase (nine years), impacting only a selected counties. The AQ impacts of long term operation of conveyance facilities appear to be insignificant for all BDCP alternatives.

Best available modeling systems have been used for AQ and GHG modeling. Emissions from heavy-duty equipment land disturbance were calculated using spreadsheets based on the methodology and default emission factors from the California Emissions Estimator Mod (CalEEMod). Emissions have been quantified for both 2025 and 2060 conditions. As expected, some of the data on personnel and equipment are unavailable, and many assumptions needed to be made, and they are clearly stated in Appendix 22A. Best available input data from DWR, EPA, ARB and ICF are used, and all conceivable sources have been incorporated in developing inventories. The effects of alternatives on air quality, criteria pollutants, and GHG emissions from construction and operations were assessed and quantified using standard and accepted software tools, techniques, and emission factors. The models employed are EMFAC 2011 (for traffic), CalFEMod (maintenance), AERMOD and variants (air quality analysis) and AERSCREEN (DPMs, assuming worst case scenarios based on individual sources).

The following comments are offered for further consideration:

(i) SMAQMD requires dispersion modeling of construction generated PM10 emissions, which has been performed using AERMOD. The results are presented in Appendix C in terms of tables with mammoth number of data points that are very difficult to interpret and frankly many readers would not care to read. It would have been of help if the results are presented in graphical form. This is particularly important since PM10 background concentrations currently exceed CAAQS and comparisons between no-action alternatives and alternatives are important. How much the construction activities increase PM concentration under various [CM 1] alternatives? Are they contributing to extra exceedance days? -- These are some questions that is important to answer. AERMOD is a source dispersion model and its capabilities are limited in the absence of well-defined mean winds, such as the case of Schultz eddy formation or summer days where slope flows may dominate in complex terrain.

(ii) No model evaluations have been done using current or past data, and hence the results have large uncertainties. If the models have been evaluated for the area, some references would be helpful.

(iii) It is curious why the ozone issue has not been addressed although there have been lengthy discussions in the introductory sections on ozone and its health impacts. Table 22.3 shows that there are substantial number ozone ‘exceedance’ days and the areas concerned are in non-attainment. Conversely, CO and NOx thresholds are rarely exceeded but the discussions and analyses on them are extensive. Perhaps it is assumed that control over precursor emissions may reduce the chemical products, but this needs to be justified and illustrated quantitatively.

(iv) The suite of models used does not include any photochemical models, and hence the formation of secondary pollutants (e.g., additional PM2.5) is excluded. In the project area, there is considerable land area with agriculture, and hence secondary pollutants can be important. A statement for the reason for exclusion (mainly comes from possible growth in agriculture) is in order.

(v) Prolonged and tortuous discussion on federal, state, county and local standards, guidelines and recommendations as well as discussions on modeling have made reading of this chapter very difficult. Some of the boiler plate material on criteria pollutions and their impacts may be removed (or relegated to an appendix), paving way to a more clear flow of essential material.

(vi) Fundamentals of global warming is described at length in the Chapter, but some of the discussion is redundant and others would fit better in §29.

III. Overall Assessment

The technical content of the paper is of acceptable standards, but it leaves some clarifications to be made in a revision, especially with regard to the ozone production and transport as well as leaving out GHG fluxes from [CM2-11]. The chapter has done an admirable job in identifying the air quality impacts of CM1 and identifying the alternatives that are environmentally benign.

Chapter 23, Noise

1. Scope of Impacts

This section identifies potential impacts of construction (short-term), maintenance, repair and operational (long-term) noise related to existing conveyance facilities and conservation measures as well as BDCP alternatives of the conveyance components [CM 1] and conservation measures [CM 2-CM22]. The no-action alternative does not significantly change the noise levels, and status quo is expected to continue, unless in the event of catastrophic events such as levee failures. On the other hand, project alternatives appear to have a significant impact due to new construction, operations, sensitive land use, worker-exposure and transportation-scenario changes. A comprehensive assessment of impacts and mitigation measures are proposed and analyzed for BDCP alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 5, 6A, 6B, 6C, 7, 8 and 9 for specific operational scenarios, followed by a cumulative analysis of noise and vibration impacts.

The goal was to consider BDCP plan area and areas of Additional Analysis (§ 4.2.1.1), but the EIR/EIS excludes SWP and CVP Export Service Areas Region. Considering localized nature of the sound and vibration effects, this assumption is justified. Existing environment is taken as typical of a quiet rural setting. The potential noise effects due to growth inducement are addressed in §30. Chapter 23 gives a good overview of different measures of specifying environmental acoustic effects, including the daytime-nighttime noise levels (DNL, from 10 pm to 7 am) and California Community Noise Equivalent level (CNEL, specific to 7-10pm). The issues identified are groundbrone vibrations as well as noise propagation through the atmosphere.

The regulatory framework includes both Federal and State. The former does not have regulatory limits for noise, but recommends limitations for specific sources such as trucks, trains and aviation (e.g., FHWA, OSHA, FRA, FTA) as well as guidance for Aquatic and Biological Resources (§11) and Terrestrial Biological Resources (§12). California Noise Control act requires the Office of Noise Control to work with communities in developing local noise control programs based on best management practices, which is addressed well in this Chapter. The procedure involves analysis and quantification of current and projected noise sources. DWR and USFWS provide guidelines for installing sound walls to shield project activities, and the decision is centered on the increase of (A- weighted) sound levels relative to a threshold of 60 dBA. In the backdrop of such an extensive but voluntary regulatory fabric, this EIS/EIR has done a thorough job of identifying existing noise levels in each potentially affected jurisdiction (which is also the NEPA/CEQA baseline) and assigning specific noise sources associated with the project. For the analysis purposes, a 40DBA level is assumed as the background, which is a reasonable value considering that most project activities are taking place in rural areas.

Major sources considered are the traffic noise, groundborne vibrations and noise from construction machinery. The estimated peak hour construction generated traffic is based on Appendix 19A, the Construction Traffic Impact Analysis Report. No action alternatives, no project alternatives and cumulative impact condition are well covered (e.g., see Tables 23-15). Local and county noise restrictions are well laid out, and potential environmental impacts of noise pollution are well articulated.

The EIR/EIS identifies mitigation measures to remediate for significant impacts. Some of the aspects covered are: groundborne vibration levels (VdB level) due to operation of heavy drilling and excavation equipment , noise exacerbation due to surface construction equipment, deliveries and worker commutes, and earth moving activities at off-site burrows and spill areas. Effects analyses include noise exposure of communities as well workers at conveyance facilities. Detailed discussions are given on activities that have potential to exacerbate noise, such as construction of intakes, tunnels, forebays, barge unloading facilities, pumping stations, conveyance facilities and transmission lines, with focus on daytime, evening and nighttime operations. The difficulty of the analysis is clearly recognized, in that the types of equipment, times of operation and the period of usage are difficult to predict so are the periods of operation of different noise sources. As such, conservative, worst-case estimates are considered where all equipment is assumed to be operational simultaneously. In most cases, the noise is identified to produce significant effects, and thus implementation of best noise-reduction practices as well as working with communities of noise-sensitive lands are recommended to realize levels of less than 60 dBA (this is not a regulatory limit but the consensus of experts followed by USFWS). The analysis also takes into account that there are no Federal or CEQA guidelines for vibrations with regard to tunnel and conveyance facility construction, and hence reasonable methods need to be used for effect analysis. Long-term operation of conveyance facilities should consider operations during daytime (7 am to 10pm, recommended limit < 50 dBA) and nighttime (10 pm to 7 am, < 45 dBA) hours.

Conversely, the FHWA and FTA have developed methods to evaluate construction noise, which is used in this chapter, although the FHWA does not recommend specific limits for dBA. Rules of thumbs commonly used for DWR projects based on CA Govt. protocols have been used in the analysis of BDCP alternatives and in recommending mitigation measures (e.g., construction of noise barriers). No action alternative includes continued implementation of SWP/CVP until 2060 and hence the effects are similar to that of the present day.

<u>II. Quality of Analysis</u>

Almost all cited literature is from reports and websites, but given the laborious nature and complexity of the analysis, the coverage is acceptable. Standard noise assessment models are used, and potential (temporary) construction noise levels were assessed using the methodology developed by FTA (2006), assuming usage of standard construction machinery and associated noise levels and exposure. Traffic Noise Modeling Lookup (TNM) model of FHWA was employed to estimate average noise levels at fixed distances from the roadway centerline based on estimated traffic volumes, types and densities. The model was programmed to produce a conservative, worst-hour estimate of traffic-generated noise levels due to heavy truck and increased commuter trips associated with construction of project and program components (§3). Some of the key aspects excluded in modeling but will have serious impacts on the project are the nocturnal atmospheric boundary layer effects and the influence of terrain and built up areas.

The following comments are offered for further consideration by the preparer:

- A Noise Abatement Plan (Appendix 3B, *Environmental Commitments*) will be in place during construction to avoid or minimize adverse effects. In this construction plan, the contractors are required to limit off-site trucking activities (e.g., deliveries, export of materials, etc.) to 6:00 a.m. to 10:00 p.m. to minimize impacts to nearby residences. Recent studies, however, show that evening period, after the atmospheric stable stratification develops (Ovenden et al., *J. Acous. Soc. Am*., 232, 1124-1237), nearby communities becomes more vulnerable to excessive noise levels because of downward refraction of sound waves. An earlier termination of trucking and construction activities should be considered. This is also applicable for selecting noise-sensitive land sites for siting conveyance facilities.

- Noise monitoring at specific locations of construction has not been mentioned in the EIR/EIS, but is recommended considering that in-situ monitoring levels can be much different than the general levels given in §23.1. Monitoring of noise during different seasons ought to be considered, considering seasonal sensitivity.
- Mitigation of noise to an acceptable level may not possible in some cases, especially during construction. Thus, more attention should be paid to long-term operations, reckoning for which can be done for different times of the day and for different climatological conditions.
- TNM Model does not take into account the terrain and buildings, and hence noise estimates must be treated with caution when clusters of buildings and above/below grade roadways are present.
- For construction activities in areas close to freeway or cities, the assumed background condition of 40 dBA is unacceptable.

III. Overall Assessment

In all, the reviewer finds that this EIS/EIR with respect to noise pollution is rigorous and extensive, and some further considerations are in order to account for possible noise refraction at night. Given uncertainties, most of the inferences are qualitative, and are expressed in terms of impacts on the overall project area rather than those over individual counties, communities and cities that may have their own noise standards. Given the overall inference that the project may have adverse noise consequences (NEPA conclusions) and that cumulative noise impact is considerable (CEQA conclusions), the Noise Abatement Plan (Appendix 3B) based on BMPs needs to be carefully designed and executed.

Chapter 25 Public Health

1. Scope of impacts covered.

Chapter 25 focuses on issues related to human health and safety that could potentially be affected by implementation of the BDCP alternatives. Topics covered include water quality, water borne illness, creation of habitat for vectors that may carry human and animal diseases, and concerns related to creation of additional electric transmission lines needed under most of the alternatives. Specifically, the chapter deals with drinking water quality as related specifically to humans, bioaccumulation of toxicants in fish and aquatic organisms that are consumed by humans, pathogens in recreational waters, disease carrying mosquitoes as vectors of human and animal diseases, and electromagnetic fields from transmission lines. Some of these topics are also included in other chapters in the EIR but pathogens in recreational waters and disease-carrying vectors are topics not addressed in any other chapters.

a) Are the impacts addressed complete (including links to other chapters)?

Although the list of topics appears to be complete, additional material should be provided in the final EIR/EIS on some of the topics covered, including potential toxicity of certain algae, biomagnification of toxic substances, control of potential vectors of disease, and consequences of water disinfection by-products. These are described below.

b) Are the impacts emphasized with respect to their importance?

Potential Toxicity of *Microcystis,* a genus of freshwater blue-green algae that can form cyanobacterial blooms, is a problem of both public health and ecological concern in the Delta .There is a large discrepancy in coverage of this topic in the BDCP and the EIR/EIS. In general, *Microcyctis* is mentioned infrequently and without detail in the EIR/EIS. Moreover, a qualitative analysis of the effects of *Microcyctis* described in the EIR/EIS indicate that in the majority of cases neither the public health nor the ecological consequences are even mentioned. In contrast, in the BDCP there is detailed coverage of this topic, and in the majority of cases the potential effects are highlighted. Most of the mentions (>10% of those found) of *Microcystis* in the EIR/EIS are in the appendices, whereas >30% in the BDCP are in the text. This discrepancy in coverage is a major shortcoming in terms of effectively evaluating effects of the alternatives and the conservation measures in this chapter in the EIR/EIS (as in other chapters as well). Moreover, in the Effects Analysis review presentation held on 28 January 2014, the issue of algal blooms was identified as a major potential impact in the Delta.

In terms of the discussion on Biomagnification of Fish and Shellfish (p. 25-8), the presentation of recommendations in a summary Table (Table 25-2. Advisories for Consumption of Fish and Invertebrate Species/Guilds for Each Waterway) is an inadequate way of dealing with this problem. Are advisories on fish and shellfish consumption the only solution when biomagnification of toxics is acknowledged as a potential problem? Moreover, biomagnification is related to issues of environmental justice in that people with lower income levels are likely to eat more fish and shellfish in the Delta region. Therefore, the biomagnification issue should be also discussed in Chapter 28.

There is extensive discussion of EMF impacts. However (page 25-22, lines 39-43) “There has been extensive research done over the past 20 years on the relationship of EMF exposure and human health risks. To date, the potential health risk caused by EMF exposure remains unknown and inconclusive. Two national research organizations (the National Research Council and the National Institute of Health) have concluded that there is no strong evidence showing that EMF exposures pose a health risk.” Given the above statement, why is so much attention given to this topic in the EIR?

2. Quality of Analysis

a) Is the literature from which the analysis builds appropriate?

References on vector control are representative of a few studies done within the Delta but far from complete. For example, virtually no peer review literature is included. In addition, there is little reference to the extensive literature on toxic algal blooms, biomagnification, and water-disinfection by products in the Delta.

b) Are the formal models and/or broad patterns of reasoning relied upon the "best available"?

Specific results and comparisons for disinfection byproducts are not discussed adequately nor appropriate and available models used. For example, (Page 25-2, lines 18-21) “The disinfection process for drinking water includes adding chlorine to drinking water sources prior to release into public drinking water distribution systems. The chlorine reacts with organic carbon (total [TOC] and dissolved [DOC]) and bromides that are in water sources and form DBPs." Concentrations of disinfection byproducts precursors (bromides and DOC) have often been modeled for this system. As a result, there is considerable analysis capability available for some of these contaminants that have not been performed in the presentation and discussion of these potential impacts. This topic is very important and potential public health effects should be discussed more fully.

c) Are the inputs (or other basic facts) to the models/reasoning the best available?
Although a great deal of information on modeling of disinfection-by product issues has been conducted, they are generally not included. Therefore, *d* and *e* below do not apply

d) Where modeling judgments and interpretive reasoning are invoked, are they appropriate?

e) Are the results and their uncertainties interpreted in a "balanced" way with respect to the strengths and weaknesses of the alternatives under consideration?

3. Overall Assessment of whether and how this chapter helps inform BDCP

There are some topics in Chapter 25 that are useful in evaluating the effects of the various alternative and conservation measures. However, we have concerns about several sections of Chapter 25 and these are presented below.

Vector Control

Several issues related to vector control need to be better addressed. For example, creation of potential mosquito habitats will not just have localized effects, as indicated in the EIR. For example, Chapter 25 states that "Potential public health impacts occurring as a result of the BDCP alternatives primarily would be localized. Given downstream flows, potential health effects from water quality-related impacts would not be transported upstream" (Page 25-2 lines 25-27; see also "Potential spread of disease through mosquitoes is expected to occur only within the study area because of the life cycle of mosquitoes and the distance they travel" (Page 25-2 lines 30-32). In the case of these water-borne vectors of disease, these statements are not correct as these newly created habitats could serve as "stepping stones" for upstream migration of adult mosquitoes and eventual lead to their colonization of new sources. The California state Mosquito Abatement Districts would be aware of this possibility and likely would disagree with the statements in the EIR as well. Objections to this statement in the EIR are also reinforced by the distances that are reported for mosquito migration in Table 25-5, where mosquito adults can travel up to 30 miles.

There are no concrete plans presented for controlling mosquitoes when their populations increase. Clearly, this is being left to the future and the activities (which are already overstretched) of the local Mosquito Abatement Districts. As stated in the EIR, "Construction of the water conveyance facilities and water supply operations under all action alternatives would result in an increase in sedimentation basins and solids lagoons. These new features could result in an increase in standing water, thereby potentially increasing vector breeding locations and vector-borne diseases in the study area". (Page 25-34, lines 18-21). This statement is correct and implementing measures under most Alternatives would increase the amounts of restored and enhanced habitat in the study area but also would result in a significant increase in mosquitoes. The conclusion is that BDCP would consult and coordinate with the various mosquito abatement districts to implement Best Management Practices (as is also mentioned in section 31.5.1.3). Several of these BMPs are mentioned from various wetland-mosquito management documents. Is this sufficient coverage of control activities in the EIR in terms of what could be major public heath outbreaks (e.g. West Nile virus and encephalitis)?

The economic cost of nuisance mosquitoes is not discussed in this chapter of the EIR. Decreases in home values, loss of recreational areas and opportunities, and increased human discomfort from increases and expansion of mosquito populations should be included. Moreover, under section 25-4 Cumulative analysis problems of disease vectors are not mentioned in the analysis. References on vector control are representative of a few studies done within the Delta but far from complete.

As with many of the other chapters, there is ambiguity in wording in many parts of Chapter 25. For example, "The availability of preferable mosquito breeding habitat varies by season, and is reduced during dry periods of the year. Available open water habitat can be expected to increase during wet season; however, changes in flow volume in the Delta would result in increased flow velocities, limiting preferable mosquito breeding habitat." (p. 25-16, lines 11-15). If the statement is meant that changes in flow volume during the wet season would not affect the mosquito populations, it would be correct because breeding is minimal at this time of the year. However, if it refers to changes in flow volume during the dry season when mosquito breeding does occur, the statement is incorrect and actually numbers would increase.

Disinfection by-products and Contaminants

Specific results and comparisons for disinfection byproducts are not discussed adequately (see comments above).

Consequences of mercury accumulation, bioaccumulation of other toxic compounds, and fish contamination are not adequately presented in this chapter of the EIR. All of these topics are commonly discussed public health concerns for the Delta, and require more detailed coverage in the EIR. The literature is extensive in these areas and not adequately represented.

Pathogens

Please see comments above about potential toxicity of *Microcystis* algal blooms not being included in the EIR/EIS, and the apparent different coverage presented in the BDCP.

Conclusion

Public Health concerns are of great importance to people living in the Delta, those that use it for recreation and other purposes, and those occupying outlying areas that may be affected by the proposed activities in BDCP. Additional consideration of the issues mentioned in this review should be given in the preparation of the final EIR/EIS document.

Chapter 26, Mineral Resources

Chapter 26 concludes that the proposed BDCP actions would harm to natural-gas production while having less-than-significant effects on aggregate.

Most of the expected impact to gas production is from conservation measures that would inundate production areas (impacts MIN-5 and MIN-6). The chapter's assessment of the no-action alternative appears to exclude such gas-field losses to unintended flooding. The assessed impact on aggregate includes its consumption by BDCP construction as well as burial of potential aggregate sources.

The chapter lays out its findings in muscular text that shows command of the subject, and in tabular summaries (Tables 26-4 through 26-7) that ease comparison among alternatives. The chapter lacks, however, an informative up-front summary, and neither the Highlights Document (p. 57) nor the Executive Summary (p. ES-130 and ES-131) make up for its absence.

Chapter 26 does not examine how natural-gas impacts MIN-5 and MIN-6 may affect the feasibility of ecosystem restoration under proposed BDCP actions. Plan Appendix 8.A, "Implementation Costs Supporting Materials" lists mitigation measures: "Avoid displacement of active natural gas wells to the extent feasible through conservation component design" and "Maintain drilling access to natural wells to the extent feasible through design of conservation components" (p. 8.A-164). Plan Chapter 8, "Implementation Costs," gives a 50-year estimate of $32 million for "mineral rights and gas-well relocation" (p. 8-14). A search on "gas" in Appendix 8.A and Chapter 8 turned up no supporting evidence for the $32 million estimate.

Chapter 27, Paleontology

Chapter 27 provides reasonable responses to the CEQA requirement for assessment of potential harm to fossils. The chapter provides an overview of paleontological resources in the Sacramento - San Joaquin Delta, Suisun Marsh, and vicinity, and it systematically estimates potential effects of the BDCP alternatives on paleontological resources. Two DISB members evaluated the chapter with help from a vertebrate paleontologist. Together we found identified areas of concern listed here:

IMPACTS CONSIDERED

The chapter considers the potential impacts to fossils, especially of vertebrates, from disturbing the ground during construction for conservation measure CM1 (water conveyance; impact PALEO-1) and for other conservation measures (habitat; impact PALEO-2). The chapter also considers such impacts from other projects that are likely to cause ground disturbance (under the non-action alternative). The chapter finds "significant" impacts in all three cases.

The findings are based on reasonable assumptions about what might turn up in excavations. In some areas the digging would reach sedimentary deposits old enough (Pleistocene and earlier) to be considered "paleontologically sensitive" (defined, p. 27-6). Macroscopic plant and animal fossils in these deposits are likely to be rare enough to be considered important (p. 27-18) as "records of ancient life" (p. 27-30).

The sensitivity ratings are typically based on (1) the potential for a geological unit to yield abundant or significant vertebrate fossils or to yield a few significant fossils, large or small, vertebrate, invertebrate, or paleobotanical remains; and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecological, or stratigraphic data (which are citeria of the Society of Vertebrate Paleontology). The ratings range from none to high. Chapter 27 states that this full range is present in the area covered by the BDCP conservation measures.

Such paleontological assessments involve a professional paleontologist examining the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may be germane to fossil preservation and potential yield.

The chapter shows greatest concern for the fossils of vertebrates. The chapter treats vertebrates as the main fossils to be expected in the Pleistocene alluvial deposits that border much of the Delta, and which extend at shallow depths beneath it. The mitigation measures specify procedures of the Society of Vertebrate Paleontology.

The chapter proposes paleontological mitigation of the BDCP conservation measures. The mitigation efforts involve planning and training meant to encourage identification, collection, and preservation of important fossils unearthed (first spelled out, p. 27-27 to 27-32). The tabular summary pages ES-131 and ES-132 state that these efforts would reduce, to "less than significant," the effects of conveyance construction for action alternative 9 (which restricts conveyance to existing channels) and the effects of all habitat construction under all the action alternatives.

CONCERNS

How valuable are the fossils in Holocene mud and peat?

The chapter could give deposits from recent millenniums more attention as paleontological resources. "Muds and peats [less than 10,000 years old] provide a rich source of microfossils for paleoenvironmental studies, but microfossils exist in the uncounted trillions throughout deposits of estuarine mud and peat. Therefore, because they are recent in age and because they seldom yield scientifically significant megafossils, estuarine sediments, including peat, are assigned low paleontological sensitivity" (p. 27-7 to 27-8). Viewed more broadly, paleoecology inferred from Holocene fossils offers guides to climatic change and to bygone ecosystems like those slated for restoration under the BDCP (Malamud-Roam et al., 2006; Canuel et al., 2009).

Will sensitive geologic units serve as sources of borrow material?

Stratigraphic units having undetermined to high paleontological sensitivity are present in some of the areas considered as potential sources for borrow material for construction activity. The vertebrate paleontologist stresses that these units, which include the Modesto Formation, Montezuma Formation, and Turlock Lake Alluvium, should not be used as a source for borrow material (Table 27-7).

Will protections vary from one county to the next?

Unlike counties that have specific requirements for paleontological resources, Sacramento, Yolo, and San Joaquin Counties place emphasis on the preservation of historic and cultural values and on compliance with CEQA without specifically considering paleontological resources. During implementation of the BDCP it would be important to apply, to all areas of BDCP conservation measures regardless of county, paleontological provisions of state and federal laws and the mitigation measures promised in Chapter 27.

What protections will areas of medium paleontological sensitivity receive?

Table 27-8 describes the Society of Vertebrate Paleontology's Recommended Treatment for Paleontological Resources for areas of high or underdetermined sensitivity. The vertebrate paleontologist recommends that these procedures should be applied to areas of medium sensitivity as well.

As the chapter states, there will be significant and unavoidable effects

Chapter 27 anticipates significant and unavoidable effects from construction of conveyance facilities (PALEO-1) and significant effects from construction for habitat conservation (PALEO-2) (summary, p. ES-130 and ES-131). The text on page 27-18, lines 25-

26, makes clear that construction of the proposed water conveyance facility (CM1) and implementing CM2–CM22 could potentially result in incompatibilities with plans and policies related to paleontological resources. Ground-disturbing activities associated with construction of the intake and pipeline could disturb units sensitive for paleontological resources. Excavation for the tunnels (necessary for Alternative 4 and more damaging under some other alternatives) would most likely destroy unique or significant paleontological resources in the Plan Area and would potentially cause significant and unavoidable paleontological impacts. The vertebrate paleontologist, while finding the Mitigation Measures proposed under "Impact PALEO" consistent with the best available practices, concluded that even with this mitigation, damage to paleontological resources will occur.

What is the primary source for a statement about levee failure?

Chapter 27 reasonably identifies levee failure as a threat to paleontological resources. The evidence cited includes an unreferenced statement that "levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (p. 27-22; reiterated from p. 9-50). This statement could be credited to page 6-37 of a seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The citation could also mention that this assessment, on its page 6-36, includes calibration in which Delta levee damage from the 1906 San Francisco earthquake is "small to moderate" for levees having "today's configuration." .

The chapter lacks a meaty summary

Like most of the rest of the draft EIR/EIS, Chapter 27 needs an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and text in the Highlights Brochure. A useful summary, placed up front, would build on the "overview" on page 58 of the Highlights Brochure. The summary would make clearer how the various alternatives, including the no-action alternative, compare with one another in terms of effects on paleontological resources. The key comparisons include no-action vs alternative 4.

The Executive Summary of the draft EIR/EIS could summarize the "significant" non-action impact more accurately. Table ES-9 lists this impact in rows for PALEO-1 and PALEO-2, where it can be misread as a puzzling effect of BDCP actions. The Table also can be misread as implying that the significant non-action impacts would somehow be made less than significant through implementation of alternative 9 (for impact PALEO-1) and of all action alternatives (for impact PALEO-2).

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Chapter 29, Climate Change

Conclusions

The BDCP Plan (and, in a less informative fashion, the EIR/EIS) does a good job of describing how climate change and sea-level rise might influence communities and species. The emphasis in Chapter 29 is on how the conservation measures of BDCP may enhance adaptation and resiliency to climate change and, especially, sea-level rise by providing flexibility in water-flow operations and additional conservation areas and habitat. Although any attempt to predict future climate at a relatively small regional scale is difficult at best, state-of-the-science modeling tools have been employed to project possible future conditions. Despite these efforts, climate change and sea-level rise, and their associated uncertainties, will remain. The likelihood and magnitude of these effects and uncertainties are not clearly stated or addressed.

Both the Plan and the EIR/EIS recognize the importance of the linkages that are created by water flows and hydrology. Synergies that result from linkages among the actions or components of BDCP, species of concern, or species not even considered may affect the potential benefits derived from BDCP actions in enhancing adaptation and resiliency to the effects of climate change or sea-level rise, yet such synergistic effects (which may be either positive or negative) receive little attention.

From a biological viewpoint, mean climate conditions are not as important as high or low extremes and their timing. Modeling and analysis of extreme events is difficult because such occurrences are unpredictable and uncertain, yet their importance merits more attention. Moreover, the potential effects of climate change and sea-level rise on water temperatures seem not to have been considered at the same level of resolution as changes in salinities. Temperature, however, is a key to most fish growth and reproductive success.

Perhaps most importantly, the potential effects of climate change and sea-level rise *on* the effectiveness of the conservation measures are not adequately considered. There is an underlying assumption that the conservation measures, if implemented, will have the desired or stated benefits or mitigation effectiveness. Because of the changing conditions, the BDCP actions may not develop as anticipated. Uncertainties in the effectiveness of conservation measures due to the effects of climate change and sea-level rise should be given greater consideration.

Chapter aims and scope

Section 85320(b)(2)(C) of the California Water Code directs that the BDCP EIR/EIS address "[t]he potential effects of climate change, possible sea level rise up to 55 inches [140 centimeters], and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the [EIR]." This is the context for the treatment of climate change and sea-level rise in the EIR/EIS.

The EIR/EIS addresses three questions about climate change and sea-level rise: (1) How will the BDCP activities affect climate change, via greenhouse gas emissions?; (2) How will BDCP impacts on resources be affected by climate change and will the effects increase in the future — i.e., are future changes in climate likely to exacerbate project impacts?; and (3) How will the BDCP activities affect the adaptability and resiliency of the Delta and its components to climate change? Question 1 is addressed in Chapter 22 on air quality and greenhouse gases. Question 2 is considered in most of the resource-focused chapters as summarized in Table 29-1 as well as in the BDCP Plan. Chapter 29 addresses only the third question. In particular, this chapter concerns how the project alternatives and conservation plans may enhance adaptation and resilience of the Delta system to changing rainfall, snowpack, water and air temperature, sea-level rise and intrusion, and evapotranspiration. In the context of BDCP, resiliency and adaptability mean "the ability of the Plan Area to remain stable or flexibly change, as the effects of climate change increase, in order to continue providing water supply benefits with sufficient water quality and supporting ecosystem conditions that maintain or enhance aquatic and terrestrial plant and animal species" (EIR/EIS p. 29-3). The current unprecedented drought in California adds weight to any measures that will enhance adaptability and resilience of water use and management, so the focus of this chapter is especially timely.

Although Chapter 29 is relatively short, the overall consideration of climate change in the EIR/EIS and the BDCP Plan is comprehensive and voluminous, but also fragmented. Thus, to evaluate how well the EIR/EIS considers the broader issues of climate change and sea-level rise and their effects, we have referred to multiple sections of the draft EIR/EIS, and to understand the foundation for the statements and conclusions we have examined parts of the Plan where the details of modeling and analysis of climate change and sea-level rise and their consequences are presented.

Assessment of climate change impacts

To evaluate how climate change relates to the actions envisioned in BDCP, it is first necessary to consider how it is projected to affect the Delta and its resources, independently of any of the conservation measures undertaken in BDCP (i.e., the No Action alternative). Various sections of the Plan and the EIR/EIS (particularly BDCP Appendix 2C and EIR/ERIS sections 29-4 and 29-5) describe the changes expected in California and in the Delta over the coming decades. These effects will be large and pervasive, creating a dynamically changing backdrop against which any environmental effects of BDCP will be superimposed. Overall, the effects of the climate changes expected for the Delta include, inter alia, (1) increased incidences of extreme hydrologic events such as atmospheric rivers (which provide significant precipitation to the Delta); (2) changing the mix and timing of rain and snow and their locations; (3) increased extinction risk of covered fish species, especially those whose ranges are located primarily in the Plan Area, due to changes in critical temperatures, salinities, and flow regimes; (4) continuing emergence of nonnative species (e.g., warm-water species) as dominant components of biological communities; (5) increased risk of species invasions due to range expansions into the region; (6) changes in sea level and salinity, which may cause increased duration and frequency of inundation of the existing wetlands; and (7) somewhat higher salinities in Suisun Bay, requiring increased Delta outflows to maintain X2 at the existing standard (BDCP p. 5.A.2-106-107). Although all of the natural communities and covered species will be affected in some way, the focus in the EIR/EIS is on long-term changes in sea level and Delta inflows that "will put increasing stresses on existing levees and make management of Delta salinity increasingly difficult" (EIS/EIR p. 3E-3) and the increased flexibility the Plan offers to control flow rates.

The potential impacts of climate change on natural communities and covered species are discussed in detail in the BDCP Plan (especially in Chapter 2, Appendix 2A, Chapter 5, and Appendix 5A). For example, the account for Delta smelt states that "modeling results projected increases in the number of days with lethal and stressful water temperatures (especially along the Sacramento River) and a shift in thermal conditions for spawning to earlier in the year, upstream movement of the LSZ, and decreasing habitat suitability" (BDCP p. 2A.1-12). These accounts, while necessarily qualitative rather than quantitative, are generally comprehensive and well-referenced.

BDCP contributions to resilience and adaptability

Chapter 29 focuses on how the actions undertaken as part of the conservation measures or mitigation for BDCP might help counter some of the effects of climate change on natural communities and covered species. In essence, the EIR/EIS proposes that the BDCP will enhance the adaptation and resilience of the Plan Area by (1) providing the flexibility in operating water flows to ameliorate conditions caused by climate change, and (2) enabling conservation efforts (C2 – C22) that will provide additional habitats or protection of key species that will help to offset any negative climate impacts. The benefits derive largely from the enhanced control and flexibility in managing hydrological flows into and through the Delta provided by the conveyance alternatives and, to a lesser extent, from the increase in quantity and/or quality of habitat created by the restoration or protection measures. For example, for tricolored blackbirds "protection, restoration, and enhancement of nesting and foraging habitat will help stabilize and increase depleted populations, helping to promote resilience to adverse effects of climate change" (BDCP p.5.A.1-28). Appendix 5.A.1 and Table 5.A.2.0-1 of the Plan provide substantial details describing which actions can enhance resilience or adaptability to CC/SLR. The benefits, while generally based on relevant literature and logical arguments, are *presumed* (or, perhaps more accurately, hoped-for) benefits; there is no assurance that they will develop as expected, and there is no discussion of what, if anything, will or can be done if they do not develop. That is, what adaptive management measures will be taken? The conclusion is that BDCP Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, and 5 would provide substantial resiliency and adaptation benefits over the No Action/No Project alternative for dealing with the combined effect of increases in sea-level rise and changes in upstream hydrology. The other alternatives would reduce resilience. Appendices 29A – 29C describe the approach to modeling and analyzing salinity effects, effects on reservoirs and inflows to the Delta, and effects on water and air temperatures.

The chapter explicitly does not include any discussion of impacts (although recognized and listed on pages 29-10 and 29-11) for which the BDCP alternatives produce no added resiliency or adaptation benefit or for which the benefits are minimal or cannot be documented; the emphasis is on potential benefits of BDCP.

Quality of analysis

The potential effects of climate change and, particularly, sea-level rise receive a comprehensive, detailed, and scientifically sound treatment when considered over the entirety of the EIR/EIS and the BDCP Plan. The effects on the key physical and biological components of the Plan Area and somewhat on the broader Delta ecosystem are thoroughly discussed. Most of the relevant information is contained in the Plan. The EIR/EIS is inconsistent in the level of detail used to assess impacts of climate change and sea-level rise on these components and the information is scattered over thousands of pages, making it difficult to evaluate how they have been treated.

Any science-based assessment of climate change and its effects necessarily begins with historical data and predictive models. Modeling climate change at the regional scale is becoming more robust, particularly when dealing with mean conditions or frequencies of extremes, The modeling approach used to assess climate change and sea-level rise in BDCP is complex, necessarily involving many assumptions and a nesting of models used in sequence to inform one another. The climate modeling is based on a modified ensemble approach, employing a quantile analysis to condense the results of the 112 downscaled model sets into a smaller set of scenarios that emphasizes mean climate conditions while preserving some of the variability among model runs (described in the EIS/EIR on pages 5A-D37-38). The approach intentionally uses a subset of scenarios to allow development of projections in greater detail, while sacrificing a more comprehensive assessment of uncertainties that would come from considering the full range of projection scenarios. This is a robust and appropriate approach. The criteria used to select the set of CC scenarios for the analyses (EIR/EIS p. 5A-A62; 5A-D33) seem sensible, and the sensitivity analysis approach used to define the boundaries for ensemble predictions (EIR/EIS p. 5A-A64) is canonical, especially in incorporating the effects of different starting points for the simulations. The potential importance of extreme events is acknowledged but, in view of their unpredictability, they are not included in the modeling (although they could be incorporated into probabilistic modeling). Instead, any unforeseen effects of extreme events will presumably be assessed through monitoring and adaptive management. The application of results to the biological communities requires additional assumptions. Also, use of mean conditions or forecasts is far less insightful than looking at critical biological factors such as summer high temperatures, rate and timing of spring warming and fall cooling, and flow rates during critical times of the years. One extreme year can do a lot of biological damage.

The RMA Bay-Delta (2D) and the UnTRIM Bay-Delta (3D) hydrodynamic models were used to simulate climate change effects of sea-level rise on Bay-Delta tidal flows, which were combined with DSM-2 for salinity modeling. These were then combined with BDCP effects to simulate future delta hydrodynamic and salinity conditions. To bracket the range of potential changes in hydrodynamics and salinities associated with wetland restoration, model simulations were conducted for several alternative restoration footprints. Changing the location of restoration affected the details of flows and salinities, but all of the scenarios reduced tidal amplitude and affected salinity (X2). Overall, the hydrological modeling shows that effects of BDCP operations and proposed restorations are limited in comparison to the impacts of climate change and sea-level rise on upstream reservoir conditions, hydrologic flows, and salinities. Several of the outstanding areas of uncertainty are (quite appropriately) explored through scenario analysis.

Recognizing that species differ in their responses to potential climate change, the Plan develops a vulnerability score based on sensitivity (including several contributing factors) and exposure (defined by natural community types). The vulnerability analysis would allow planners and managers to design conservation actions and monitoring programs to allow them to focus on the covered species most vulnerable to the effects of climate change and the habitats that support a large number of vulnerable species (see BDCP page 5.A.1-35). However, because different species respond differently to climate changes, some will be affected by things that can be moderated and some will be affected by things that cannot be modified. For those in the first category, each operation might benefit each species a little differently; how will choices be made? Moreover, while listing the species most vulnerable to changes in climate is an important step toward prioritizing conservation actions, we should not forget that we are dealing with an ecosystem and indirect effects of climate change (changes in rates, distributions, species interactions, food webs, etc.) are also important. Despite the attention given to developing species' vulnerability scores in the BDCP Plan, it does not figure into any of the analyses or documentations in the Plan and is not mentioned in the EIR/EIS.

Overall, considering the material in both the BDCP Plan and the EIR/EIS, the potential effects of climate change and sea-level rise on components of the Delta ecosystem and the current and proposed water operations are treated comprehensively and in considerable detail. Points are supported by relevant literature (at least in the Plan), some of it quite recent. The models are carefully reasoned and are used effectively to explore both consequences of CC/SLR and important areas of uncertainty. That said, however, there are several areas in which the presentation and analyses could be improved.

Areas of concern

There are several areas of concern with the treatment of climate change in the EIS/EIR that these are not resolved in the coverage in the BDCP Plan itself.

Most importantly, although the potential effects of climate change and sea-level rise on natural communities and covered species are discussed in detail (in the Plan) and are included in the modeling of hydrodynamics and the associated tidal wetland restoration and in the discussion of reservoir operations, the possible impacts *on* the conservation measures are apparently not considered. The EIR/EIS includes detailed calculations of the anticipated losses of habitat (acreages) due to various BDCP actions and how these losses will be balanced (in most cases exceeded) by acres of habitat (often of greater value) protected or restored. In some instances, additional measures (Avoidance or Minimization Measures or Mitigation Measures) will be required to achieve the necessary balance and avoid detrimental effects on a community or species. There is an unstated assumption that the anticipated habitat protection, restoration, and mitigation will in fact materialize. But climate change is projected to have significant effects on the amount, quality, and locations of habitat, potentially adding to the losses. The effectiveness of habitat protection and restoration may be compromised by climate change or sea-level rise, eroding (figuratively and literally) the conservation gains or benefitting less desirable species such as warm-water predators or invasives. As a result, the anticipated balancing of new conservation areas to offset climate impacts and the BDCP may not develop as planned.

It is possible that these effects are included in the calculations of the EIR/EIS (e.g., in Chapter 12), but we found no indications of such adjustments. Rather, it seems apparent that the potential effects of climate change and sea-level rise on the effectiveness of habitat protection, restoration, or other conservation measures are not specifically addressed in the EIR/EIS because the intent of this document is to evaluate whether BDCP will lead to consequences that would not otherwise have occurred (this is why the effects of climate change and sea-level rise are included in the no-action alternative). BDCP actions will not alter climate change or sea-level rise (Chapter 23); rather, the effects of climate change and sea-level rise are projected to trump any effects of BDCP actions. For example, "The results [of hydrological modeling] show that the effects on the upstream operations are primarily due to the climate change effect on the reservoir inflows, river temperatures, and the increased salinity intrusion in the Delta due to the projected sea level rise. The proposed BDCP operations did not impact the upstream reservoir conditions, both at end-of-May and end-of-September, because of the increased flexibility in the system [i.e., resilience]. The proposed restoration under BDCP has limited effect on the overall system operations" (BDCP p. 5A-D157). Considering that the overall rainfall levels at reservoirs are projected to be essentially unchanged but the timing of snow and precipitation will change, there is little doubt that additional BDCP conveyance and storage capacity would be useful in managing water in the Delta, but without including such adaptive management measures in modeling it will be difficult to predict the salinity and temperature levels as well as impacts on habitats downstream.

There are also considerable uncertainties associated with any potential effects of climate change and sea-level rise on BDCP actions, providing further justification for not considering these effects in the EIR/EIS. To ignore these potential effects on the conservation measures (primarily habitat protection and restoration) that are intended to be part of achieving net benefits from BDCP, however, may be short-sighted. It is anticipated that any failures of protection and restoration (or other actions) to realize the desired outcomes will be detected by monitoring and adjusted through adaptive management. However, this relies on how well and how quickly monitoring and adaptive management can or will be implemented. We consider this issue, and the wisdom of planning for contingencies in case things don't work out as planned, elsewhere in our report.

A second concern has to do with linkages. What happens or is done at one place and time for one species, for example, may have ripple effects that extend to other places at other times and affect other species. Climate change and sea-level rise will likely affect everything in and surrounding the Delta, everywhere, in one way or another. The scope of climate change as a driving force is broad in both space and time, although the consequences may be more localized and short-term or episodic. Consequently, considering the effects of climate change or calculating the potential benefits derived from separate BDCP actions in enhancing the resiliency of each ecosystem component separately may fail to recognize the synergies that result from the linkages among the actions or components, species of concern, or species not even considered. Although the web of direct and indirect linkages among components of the Delta ecosystem are tremendously complex (and therefore plagued by uncertainties), it would be worthwhile to give them more thought, particularly because recognizing linkages and feedbacks may make management actions more effective or avoid unintended consequences. Both the Plan and the EIR/EIS recognize the importance of the linkages that are created by water flows and hydrology; similar attention should be given to biological, physical, and chemical linkages between aquatic and terrestrial elements or among elements of terrestrial landscapes.

A third concern is about modeling. A chain of models has been used to predict the 2025/2060 hydrology, salinity, and water temperature. As pointed out above, however, the influence of local adaptive management measures can have an up-scaling effect system-wide. The models used are well studied and evaluated, but sometimes they lack critical components. For example, the CALSIM-2 runoff model does not have a good linkage to ground water, the mixing parameterizations used are not valid for very high flow rates (model calibrations may not be applied for extreme precipitations of future climate), and the DSM2 flow-salinity relations may not be valid for extreme future climate scenarios. Thus, uncertainties abound.

Finally, two additional points. First, there is some discussion in both the Plan and the EIR/EIS about the changes in mean conditions, particularly changes in mean temperature. However, what may be most important to fish (and other aquatic organisms), particularly for those species living on the edge of their thermal tolerance, are increases in the highest temperatures. The timings of the increased temperatures and of the fall cooling are also important to aquatic organisms. Some species may benefit from the longer, warmer growing season while others will be stressed by a longer period of warmer temperatures.

Second, although Chapter 29 deals mainly with flexibility of water-flow operations and does include climate impacts on physical conditions (e.g. precipitation and sea-level rise) outside of the Plan Area, it ignores potential regional influences of climate change on biological components elsewhere. For example, the survival of anadromous fishes in the ocean or during their migrations to and from the Delta will be affected by climate changes, and range expansions or distributional shifts of species in response to climate-driven habitat changes elsewhere may have impacts on species and communities within the Plan Area, and on the effectiveness of conservation measures undertaken to enhance their populations or mitigate the effects of BDCP actions. While such effects are couched in uncertainty, they should not be ignored.